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Indications and Regenerative Techniques for Lateral Window Sinus Floor Elevation With Ridge Augmentation

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ABSTRACT

Maxillary sinus elevation is a critical procedure in dental implantology, often necessary to address bone deficiencies in the posterior maxilla. However, various medical conditions, local factors, and surgical complexities can significantly influence the outcomes. This article delves into the implications of systemic conditions such as smoking, diabetes, osteoporosis, antiresorptive and antiangiogenic medications, radiotherapy, immunocompromised states, cardiovascular diseases, chronic alcoholism, and oxidative stress on sinus floor elevation and associated dental implant placements. Each condition presents unique challenges and necessitates tailored clinical considerations to mitigate risks and enhance surgical success. A comprehensive pre-operative assessment is essential, including detailed patient history and radiographic evaluation. Local conditions affecting the maxillary sinus, such as sinusitis, require careful examination and possible otolaryngologist consultation. The article discusses a standardized Digital Surgical Planning (DSP) protocol involving CBCT imaging, intraoral scans, virtual diagnostic wax-ups, and guided implant placement to optimize surgical planning and outcomes. Surgical techniques for lateral window antrostomy are examined, including flap design, window size and location, and piezoelectric and rotary instrumentation. Subsequent regenerative procedures involve meticulous membrane elevation and particulate graft placement, with considerations for graft material and technique to ensure stability and volume retention. Post-operative care, encompassing antibiotic prophylaxis, corticosteroid use, and decongestants, is outlined to prevent infections and manage edema. Conclusively, the article stresses the necessity for implantologists to be proficient in various techniques and make evidence-based decisions tailored to individual patient needs, ensuring optimal implant therapy outcomes. The lateral window approach remains a cornerstone of regenerative dental procedures, maintaining its significance through evolving methodologies and clinical advances. The lateral window sinus elevation procedure has demonstrated consistent success as a pre-prosthetic surgical intervention for over four decades, supported by multiple reviews. Initially a hospital-based procedure requiring autogenous bone harvesting, it has evolved into a minimally invasive, office-based procedure without the need for donor bone. Smaller access windows and flaps have further reduced morbidity. Despite the emergence of less invasive techniques such as the transcrestal approach and the use of tilted or short implants, the lateral window procedure remains relevant due to its unique advantages: Provides greater access

to overcome obstacles like septa. Facilitates single-surgery management of multiple implant sites. Remains applicable regardless of residual crestal bone height. Allows intraoperative management of complications such as membrane perforations.

1 | Introduction

Maxillary sinus augmentation has been integral to our surgical practices for over four decades [1]. Throughout this period, numerous advancements in our surgical methodologies have evolved due to continuous clinical and scientific innovations, the emergence of innovative products and technologies, the pursuit of increasing procedural efficacy, reducing complication rates, and the preference for minimally invasive surgical techniques [2]. It is noteworthy that sinus augmentation initially emerged as a hospital-based procedure involving the use of extraoral autogenous bone grafts.

Sinus floor elevation aims to provide endo-sinus bone gain to achieve sufficient bone-to-implant contact for the functional requirement of dental implants [3]. Generally, sinus floor elevation indicates reduced vertical bone height in the maxillary molar, premolar, and anterior (in cases of extensive sinus pneumatization) regions.

This narrative review aims to illustrate the state of the art in the following steps of sinus floor elevation:

2 | Diagnostic Phase

2.1 | The Medical Conditions That Could Affect the Outcome of the Procedure

2.1.1 | Smoking

Smoking is associated with systemic and local inflammatory cytokine levels, local immunity, and interference with osteoclast differentiation and activation [4]. Smoking is potentially associated with the thickening of the Schneiderian membrane [5]. An early systematic review summarized data from eight studies and 3326 implants and reported a negative effect of smoking on implant survival after sinus floor elevation (RR 1.87, 95% CI 1.35 to 2.58, $p < 0.001$) [6]. In addition, smoking is negatively associated with long-term marginal bone loss of dental implants placed following sinus floor elevation [7]. While other studies reported that smoking did not significantly influence endo-sinus bone formation [8].

Regarding complications, smoking was reported to increase the risks of post-operative complications after sinus floor elevation (14.2% vs. 2.2% in 124 procedures) [9]. This was similar to another study reporting that smoking was associated with increased risks of wound dehiscence (or = 16.1), sinusitis (odds ratio [OR] = 12.3), and membrane perforation (OR = 4.8) [10]. Currently, there is no information on the dose effect of smoking on dental implant placement or bone augmentation procedures or a wash-out period where the effect of smoking disappears after quitting, similar to periodontal surgical procedures [11].

Clinical Implications Smoking is not a contraindication for sinus floor elevation; however, heavy smokers (1 pack/day) must be evaluated with caution since the rate of post-op complications is higher, and the patient should be fully informed of this possibility. Clinicians should consider opting for alternative treatments to sinus elevation [12].

2.1.2 | Diabetes

Diabetes is associated with impaired microcirculation, impaired bone metabolism, increased inflammatory levels, and higher risks of infection, which influence sinus floor elevation outcomes [13]. In animal studies, diabetes compromises the osseointegration process [14] and impairs the established osseointegration [15]. In addition, poor glycemic control in diabetes is associated with periodontal conditions [16]. Although recent studies have reported implant placement in patients without proper glycemic control [17], it is recommended that improving glycemic control be a behavior intervention for the prevention of peri-implant diseases [18]. For sinus floor elevation and implant placement in patients with diabetes, a thorough inquiry of medical history at the first visit, sufficient glycemic control, anti-microbial therapy before and after surgery, and reinforcement of patient self-plaque removal are important.

Clinical Implications Managing diabetes through medical assessment is essential for successful SFE, as diabetes can impair implant osseointegration and increase the risk of infections. Implementing anti-microbial therapy and promoting diligent oral hygiene are crucial to preventing peri-implant diseases in diabetic patients.

2.1.3 | Osteoporosis

Upon examining the current data on late implant failure, numerous systematic reviews and meta-analyses have found no significant link between osteoporosis and the failure of implants [19–21]. Specifically, de Medeiros's analysis, which included 8859 patients and 29 798 implants, revealed no differences in implant survival rates between individuals with osteoporosis and those without. This was consistent at the implant level (RR 1.39, $p = 0.11$) and the patient level (RR 0.98, $p = 0.94$) [19]. Similarly, a meta-analysis by Lu et al. and Chen et al. could not demonstrate a significant detrimental effect of osteoporosis on implant survival (RR = 1.19, $p = 0.067$; RR = 1.09, $p = 0.14$, respectively) [20, 21].

There are no documented contraindications for placing implants in patients with osteoporosis. Nonetheless, the bone healing process may be prolonged, and the poor quality of bone could impact primary stability, potentially affecting osseointegration as well [22]. While no studies specify the exact healing time for these cases, it is generally suggested that extending the standard waiting period by 50% should be adequate. Additionally, opting to under-prepare the implant site or using a wider implant than

usual may prove advantageous [23]. In many ways, this condition does not appear to inherently limit implant therapy. However, treatments involving bone resorption inhibitors could potentially lead to serious post-surgical complications for the patient.

Clinical Implications Osteoporosis does not contraindicate implant placement but extended healing times and careful site preparation or implant selection may be necessary due to compromised bone quality and primary stability. Additionally, caution with bone resorption-inhibitor therapy is advised to avoid serious post-surgical complications.

2.1.4 | Antiresorptive and Antiangiogenics Medications

Estimating the risk of developing osteonecrosis of the jaw (ONJ) in patients undergoing antiresorptive therapy necessitates a thorough evaluation of the patient's overall health and dental history. Numerous systemic and local risk factors can contribute to the onset of medication-related osteonecrosis of the jaw (MRONJ). Key factors include the type of drug, the route of administration, and the duration of therapy. Research indicates that the risk of MRONJ is considerably lower in patients treated with oral bisphosphonates (BPs) than those receiving intravenous BPs [24], with an incidence of spontaneous osteonecrosis of 0.01%–0.04% and 0.8%–12%, respectively [25]. Then, some studies concluded that the duration of treatment with antiresorptive drugs significantly influences the onset of ONJ, as a consequence of a cumulative dose load [26].

It is advisable to follow the latest guidelines of AAOMS 2022 for the prevention of the Medication-Related Osteonecrosis of the jaws [27] (Table 1).

Careful monitoring and clinical and radiographic surveillance should be ensured in patients undergoing implant therapy throughout the healing phase and in the following years. Antiangiogenic inhibitors have the potential to increase the risk of MRONJ development. They should be carefully assessed, and their suspension should be considered according to an oncologist's recommendations to slow down the progression of MRONJ [28].

Clinical Implications Assessing the risk of developing MRONJ in patients on antiresorptive therapy necessitates a thorough evaluation of the patient's general and dental history, as systemic and local risk factors, including type, administration route, and therapy duration, significantly influence its onset. Adherence to AAOMS guidelines and monitoring during and after implant therapy is essential, particularly when using antiangiogenic inhibitors, which may necessitate suspension per oncologist recommendations to mitigate MRONJ risks.

2.1.5 | Radiation Therapy

Radiotherapy represents a clear risk factor for dental implants and bone augmentation procedures [29] and at the same time, the xerostomia-induced in these patients could make prosthetic rehabilitations with mucosal support less functional and comfortable [30].

Implant therapy should only be considered a relative contraindication in patients undergoing radiotherapy, yet several factors can then influence the efficacy and survival rates of dental implants in patients candidate for radiation therapy [31]. The anatomical location of the implants is a significant risk factor. Research indicates that implants positioned in the maxilla have double the risk of failure compared to those placed in the mandible [32, 33]. In particular, Ilhe et al. comparing maxillary and mandibular implants revealed an adjusted RR of 1.79 in favor of mandibular ones [32]. Chambrone et al. and Javed et al. documented a markedly higher likelihood of implant loss in maxillary sites. Specifically, they reported a 496% increased failure risk (Risk ratio: 5.96, $p < 0.0001$) and a 300% higher risk when compared to the mandible [6]. Indeed, the greater primary stability achieved with implant placement in the mandible could explain the results when early failure is considered [6, 34]. Conversely, improved long-term outcomes might be anticipated in the maxilla due to better secondary stability and a higher percentage of vascularized marrow, which could help counteract the adverse delayed vascular effects of radiation [35]. Some authors have also identified a significant reduction for implant survival rate in irradiated grafted sites compared to irradiated native bone, due to lower vascularity and density of regenerated bone [36, 37].

Another critical risk factor influencing the success of implant therapy is the radiation dose affecting the bone tissue. There appears to be a dose–response relationship, with higher radiation doses correlating with increased rates of implant loss. Esposito et al. demonstrated higher failure rates with radiation doses exceeding 50 Gy and 55 Gy [38].

Furthermore, the amount of radiation also appears to influence the risk of Osteoradionecrosis (ORN) associated with implant therapy [31]. Lee et al. established a cut-off not to be exceeded in order not to run into the ORN risk of 61.5 Gy; other authors, however, reported values of 50–55 Gy [31–39].

Another factor that the clinician must consider is the exposure dosage are the Anderson et al.'s guidelines [40]:

- < 50 Gy: indicates a low risk of implant failure and recommends the adoption of standard precautions.
- 50–65 Gy indicates a moderate risk and recommend caution.
- 65–74 Gy indicate a relatively high risk and advise against the placement of implants unless hyperbaric oxygen therapy is also used.
- 75–120 Gy implant therapy is not recommended due to the high associated risks [40].

Clinical Implications Radiotherapy poses significant risks for dental implants and bone augmentation procedures, with xerostomia further complicating prosthetic rehabilitations. Implant therapy in irradiated patients should be considered cautiously, as factors such as location and dose of radiation and bone condition critically impact implant-success rates. Guidelines suggest specific precautions and contraindications depending on radiation exposure levels.

TABLE 1 | The maxillary sinus elevation difficulty score worksheet.

Difficulty scoring			
Risk factors for perforation	**0 points**	**1 point**	**2 points**
Anatomic-related factors			
Sinus membrane thickness	1.5–2.0 mm	0.8–1.49, 2.01–2.99 mm	< 0.8, > 3 mm
Presence of sinus septa	Absence of septa	One septum	Multiple septa or septum
Direction of sinus septa	Absence of septa	Medio-lateral (transverse)	Antero-posterior (sagittal)
Height of sinus septa	Absence of septa	Height < 6 mm	Height ≥ 6 mm
Type of edentulism and root position relative to the sinus cavity	Totally missing teeth (from second premolar to second molar)	Two adjacent missing teeth (between first premolar to second molar)	Single missing tooth (between second premolar to second molar)/presence of teeth at the sinus elevation area and root into/close to the sinus lift area
Residual bone height	> 4 mm		< 4 mm
Sinus width (angle between the lateral and the medial walls)	Wide (angle > 60°)	Angle within 30°–60°	Narrow (angle < 30°)
Palatonasal recess angle	Obtuse (≥ 90°)		Acute (< 90°)
Alveolar antra artery	Diameter < 1 mm	Diameter 1–2 mm	Diameter > 2 mm
Buccal wall thickness	< 1 mm	1–2 mm	> 2 mm
Zygomatic arch location	Apically positioned		Coronally positioned
Bone dehiscence	Absent	Presented at the buccal wall	Presented at the ridge level or the medial wall
Patient-related factors			
Smoking habit	No		Yes
Pre-operative chronic sinusitis	No		Yes
Gingival phenotype	Thick (≥ 1 mm)		Thin (< 1 mm)
Surgical access	Wide		Narrow
Surgical accesselevation site relative to the surgeon's dominant hand	Left side for left-handed surgeon or right side for right-handed surgeon	Left side for right-handed surgeon or right side for left-handed surgeon	
Simple procedure	0–8 points in the maxillary sinus elevation difficulty score		
Moderate procedure	9–16 points in the maxillary sinus elevation difficulty score		
Difficult procedure	17+ points in the maxillary sinus elevation difficulty score		

2.1.6 | Immunodepressed Patients and HIV

Steroid derivatives, such as corticosteroids, are medications used to treat a variety of conditions, including asthma and autoimmune diseases like rheumatoid arthritis, pemphigus vulgaris, lupus erythematosus, Sjogren's syndrome, and polymyalgia rheumatica. Additionally, immunomodulatory drugs are prescribed to patients with organ transplants. These patients often use corticosteroids alongside other medications like cyclosporine, tacrolimus, sirolimus, and mycophenolate. Current evidence indicates that there are no contraindications for implant therapy in patients experiencing drug-induced immunosuppression and those with organ transplants [41].

Although the existing evidence is limited and sometimes inconsistent in providing clear guidelines for treating HIV+ patients

undergoing implant therapy, dental implants are generally not contraindicated for individuals with AIDS. Maintaining long-term CD4+ T lymphocyte levels above 250 cells/mm^3 appears to be crucial in reducing the risk of impaired osseointegration and implant failure rates in these patients [42, 43]. Additionally, studies, though sometimes yielding controversial results, suggest that effectively managing major risk factors like heavy smoking (over 10 cigarettes per day), uncontrolled periodontitis, and poor hygiene compliance can ensure the success of implant therapy even in HIV+ patients. Antiretroviral therapy does not pose a contraindication for oral rehabilitation treatments [42, 44].

Clinical Implications Steroid derivatives and immunomodulatory drugs used for autoimmune diseases and organ transplant patients do not present contraindications for implant therapy, as current evidence does not indicate significant risks. In HIV+ patients, implant therapy is generally safe provided that CD4+ T lymphocyte levels remain above 250 cells/mm^3, in addition to major risk factors like smoking, periodontitis, and poor hygiene are well controlled, with antiretroviral therapy not being a contraindication.

2.1.7 | Cardiovascular Disease and Anticoagulant Therapy

Implant placement is absolutely contraindicated in patients who have had a recent myocardial infarction or cardiovascular event within the last 6 months, as serious complications are more likely to occur during this period. Similarly, patients who have undergone heart valve replacement surgery should also wait at least 6 months before considering implant therapy [45]. In any situation, proper antibiotic prophylaxis is essential to prevent the development of endocarditis. Another crucial aspect to consider is the potential use of anticoagulants or antiplatelet drugs. When treating patients on vitamin K antagonists or direct oral anticoagulants (DOACs), it is recommended to assess the International Normalized Ratio (INR). INR values between 2 and 4 do not contraindicate implant placement, provided it is associated with minor surgical procedures [46]. Considering that less invasive procedures are associated with a lower risk of bleeding, weighing the planned surgery type is always necessary. More complex interventions, such as the insertion of bimaxillary or zygomatic implants and the use of bone grafts, correlate with a higher risk.

Clinical Implications Implant placement is contraindicated in patients within 6 months of a recent myocardial infarction, cardiovascular attack, or heart valve replacement surgery, and adequate antibiotic prophylaxis is essential to prevent endocarditis. Anticoagulants, particularly vitamin K antagonists or direct oral anticoagulants (DOACs), require careful INR assessment, with values between 2 and 4 generally not contraindicating minor surgical procedures. However, more invasive surgeries carry higher bleeding risks.

2.1.8 | Chronic Alcoholism

Several clinical studies have investigated the potential correlation between alcohol consumption and peri-implant bone resorption. In a prospective clinical study conducted by Galindo-Moreno et al., multivariate linear regression analysis identified alcohol use, implant surface area, and gingival index as significant variables associated with peri-implant bone loss. Furthermore, the study found that the mean marginal bone loss (MBL), adjusted for implant surface area and gingival index, was significantly higher in alcohol users (1.49 mm) compared to non-users (1.23 mm) [46].

In a retrospective case–control study, Block et al. utilized backward variable selection to predict implant failure within different time frames: within 1 year, between 1 and 4 years, and after 4 years. They conducted three multivariable logistic regressions and found that, among other factors, alcohol consumption was associated with an increased likelihood of implant loss during one or more of these periods [47]. A matched case–control analysis by Alissa and Oliver revealed a higher incidence of implant failure in patients who consumed more than 5 units of alcohol per day, compared to non-drinkers or those who consumed fewer than 5 units per day [48].

At present, the available evidence is not sufficient to declare alcoholism a contraindication to implant therapy. However, patients undergoing such therapy may encounter various complications, including altered bone metabolism, bleeding issues stemming from liver diseases, and an increased susceptibility to infections due to compromised immune systems.

Clinical Implications Based on limited evidence, alcohol users may face complications related to altered bone metabolism, increased bleeding risks, and heightened infection susceptibility due to compromised immune systems.

2.1.9 | Oxidative Stress

Oxidative stress is an imbalance in the production of free radicals and in the antioxidant system, so it could be measured by monitoring some useful parameters: ROS, malondialdehyde (MDA), superoxide dismutase and total antioxidant capacity (TAC) [47]. All these parameters are present also in peri-implant crevicular fluid (PICF) [48].

Systemic conditions and/or an unhealthy lifestyle can directly result in surgical complications, hinder the healing process of the implant and surrounding bone, or impact long-term peri-implant health and its response to biological challenges. These risks may also be associated with the medications taken by implant patients, rather than the underlying disease itself [49].

There is no reported contraindication for implant placement in patients with elevated oxidative stress. However, there is evidence that lowering the levels of reactive oxygen species (ROS) could help the healing process of peri-implant bone tissue [50–52].

Clinical Implications Although elevated oxidative stress is not formally contraindicated for implant placement, evidence suggests that reducing reactive oxygen species could enhance peri-implant bone healing, while systemic conditions, unhealthy lifestyles, and certain medications may increase surgical

complications and affect both immediate and long-term implant health.

2.2 | Local Diseases/Conditions

During the initial consultation, gathering a comprehensive history of any conditions that may affect the maxillary sinus is crucial. This includes nasal obstructions, facial trauma, sinus infections, allergic symptoms, dysfunctions in smell and taste, discomfort related to changes in atmospheric pressure, chronic respiratory diseases, previous nasosinusal surgeries, facial deformities, scars, and mouth breathing [53]. If the patient's medical history is positive for sinus-related issues or if there are symptoms of sinusitis, it is recommended to seek a consultation with an otorhinolaryngologist [54].

The same evaluation should be conducted in cases that exhibit radiologic signs of radiopacity, a history of sinus treatments, impaired nasal breathing, and chronic respiratory diseases. Additionally, acute rhinosinusitis may serve as a temporary contraindication to sinus surgery, as it is often challenging to distinguish between viral and bacterial infections [55]. If symptoms regress or the patient improves within less than 5 days without any treatment, it can be assumed to be a common cold, which may be effectively treated with analgesics, nasal saline irrigation, and decongestants. However, if symptoms persist beyond 10 days of treatment, a consultation with an otorhinolaryngologist is mandatory before proceeding with sinus surgery. Following appropriate treatment of the infection, a 30-day waiting period is recommended to ensure adequate mucosal trophism and osteomeatal complex patency [56, 57].

The recommendations illustrated in Figure 1 are intended to guide implantologists in collaborating with otorhinolaryngologists to determine the appropriate course of treatment in light of radiologic findings in the sinus. Any radiologic findings should be interpreted in conjunction with a thorough sinus history and an evaluation of any clinical symptoms the patient may exhibit [53].

Nowadays, the thickening of the sinus membrane >4 mm is not a discriminant factor to consider when determining whether maxillary sinus elevation is possible. The opening of the natural ostium plays a pivotal role in assessing the proper functionality of the maxillary sinus; if the natural ostium is closed, a pre-operative otolaryngologist consultation is mandatory [58, 59].

2.3 | How to Plan for Maxillary Elevation and Adjunctive Regenerative Procedure

The indication for sinus elevation is moderate atrophy of the upper maxilla with moderate vertical and horizontal bone resorption. This allows the creation of prosthetic elements with an apicocoronal length increased by no more than 20% (usually 1.5–2 mm) compared to the controlateral natural teeth. However, if these conditions are not met, it would be necessary to consider a surgical technique where vertical and horizontal bone reconstruction is performed simultaneously with maxillary sinus elevation. This former procedure, however, presents more uncertainties than sinus surgery, and various authors have reported significantly different results in terms of average vertical bone increase. According to recent data, an operator with intermediate expertise can achieve an average vertical bone increase using guided bone regeneration (GBR) of 4.18 mm. The most encountered complication is wound dehiscence with or without graft infection, with an average incidence of 12.1% of cases. Interestingly, the incidence of possible complications increases to an average of 23% when resorbable membranes are used and decreases to 7% when non-resorbable membranes are used. The DSP protocol was created to propose a rational choice for the type of bone reconstruction performed on the patient to carry out a “prosthodontically oriented” surgery.

DSP Protocol: The request for an extended CBCT of the upper dental arch, including the maxillary sinus, is the starting point for planning a maxillary sinus elevation procedure. Our group has already defined a series of parameters to analyze to determine the case's difficulty, thus informing the operator about the surgery's complexity (Figure 2). After staging the case, we can define the optimal position A-C of the implants in three simple steps:

1. *Prosthetic space evaluation*: Obtain two intraoral scans of the patient and overlay them with the CBCT data to determine the position of the soft tissues in space, which is not always visible in the CBCT due to cheek or tongue interposition during the scan.
2. *Virtual diagnostic wax-up*: Using implant planning software, create a virtual diagnostic wax-up that adheres to the parameters mentioned above, that is, the apicocoronal length of the dental elements should not exceed 20% (usually 1.5–2 mm) compared to the contralateral prosthetic elements, if present, or the standard dimensions. You can also import a virtual diagnostic wax-up created by the dental technician.
3. *Implant planning*: Guided prosthetically oriented implant placement, considering the soft tissue thickness, ideally around 2–3 mm. With values higher than 3–4 mm, vertical bone reconstruction is indicated to bring the length into a normal range.
4. *Prosthesis emergence angle evaluation*: The angle formed between the prosthesis and the alveolar ridge should be greater than 130°. A sharper angle can result in food accumulation and retention in the prosthesis's apical portion, causing hygiene maintenance difficulties.

Particular attention should also be paid to the position of the maxillary zygomatic process, as a very crestal insertion would create significant difficulties not only in performing an extrasinus regenerative procedure but especially in the second surgical phase, where recreating an adequate fornix depth would be very complex. Therefore, it is clear how performing a preoperative evaluation in a digital environment allows us to examine many parameters that were left to the operator's sensitivity and experience in the past. However, carrying out this type of evaluation is simple. Today, for maxillary sinus elevation planning, it is already the gold standard to request a CBCT of the upper dental arch extended to the maxillary sinus. The only

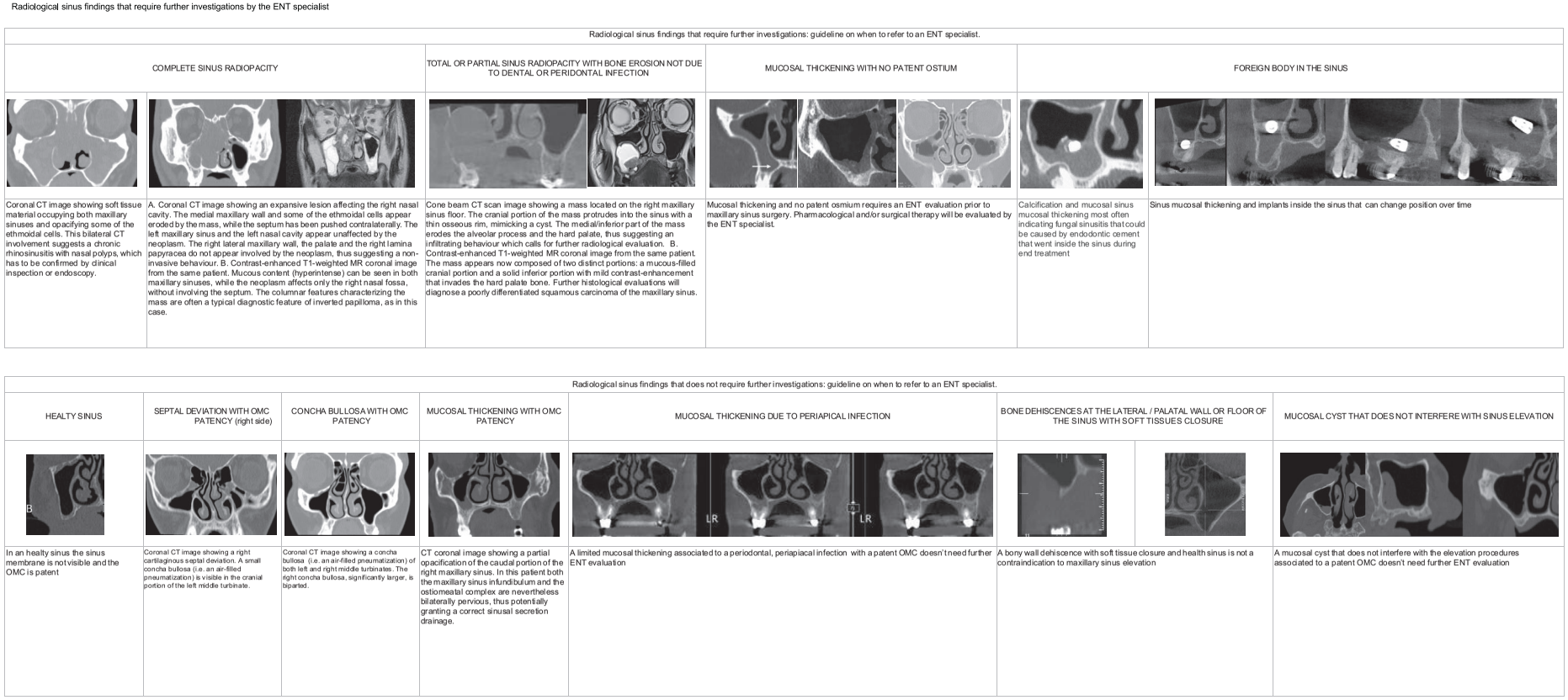


FIGURE 1 | Radiologic sinus findings that require and does not require further investigations by otorhinolaryngologist. CT, computed tomography; otolaryngologist, ear, nose, and throat; MR, magnetic resonance; OMC, osteomeatal complex. Reprinted from Testori et al. 2023 [55] with permission from Wiley.

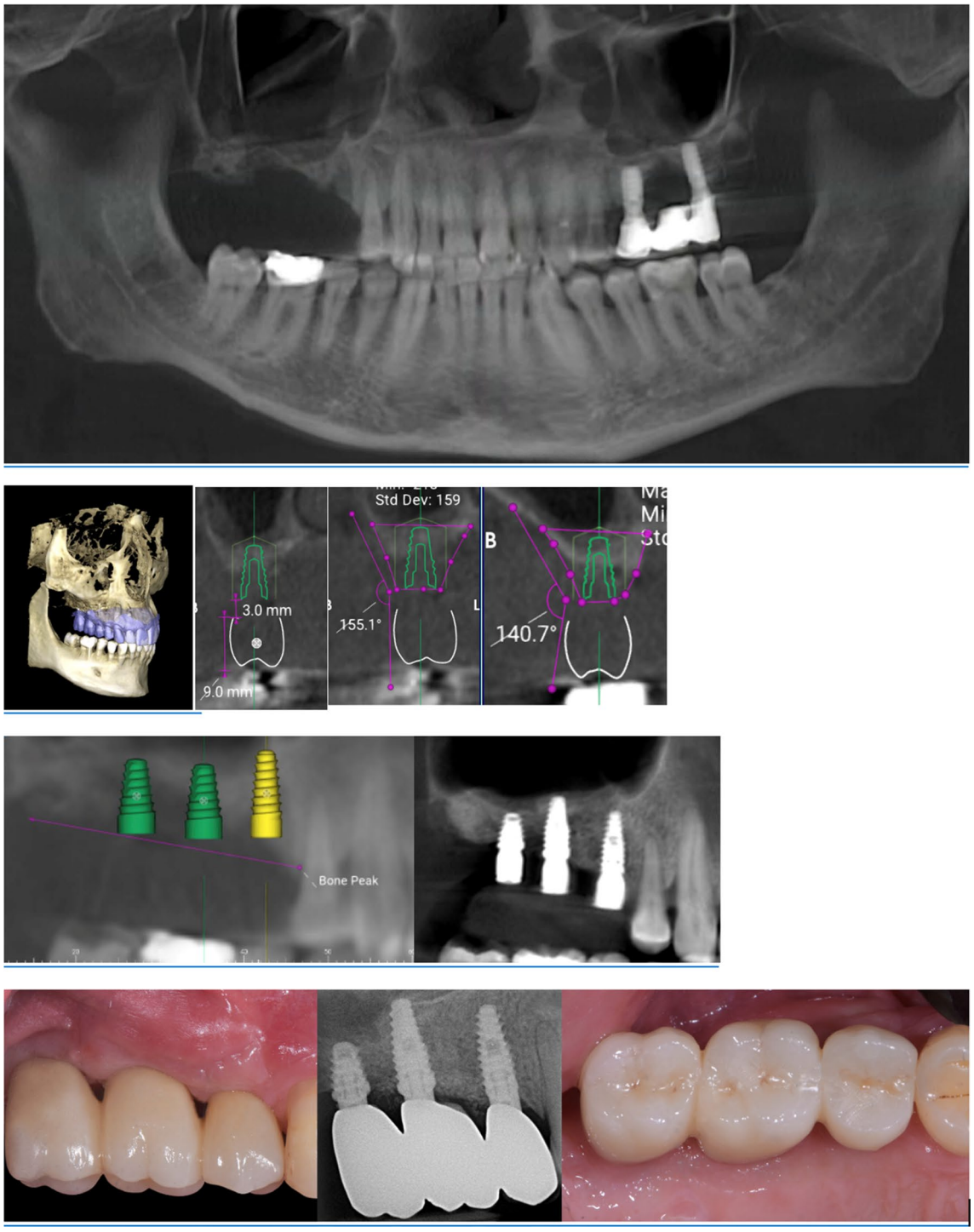


FIGURE 2 | The Digital Surgical Planning (DSP) Protocol: CBCT scans are superimposed to the intraoral scans to produce a virtual wax-up, the future prosthetic restoration is planned in the ideal place, then implants are placed according to the position of the prosthetic restoration. Additional hard and soft tissue grafting are then planned.

additional steps are to record a digital intraoral scan (or traditional analog impression that would be acquired and digitized in the laboratory) and create a virtual diagnostic wax-up to combine this information with the CBCT radiological data within specific software for case design. Using these tools can provide our patients with more predictable results and highlight any critical issues before starting treatment, allowing for time and planning to correct them.

2.3.1 | Soft Tissue Compensation to Address Mild Vertical and Horizontal Bone Deficiency

3D tissue deficiency could be addressed by bone grafting or soft tissue grafting utilizing periodontal plastic surgery concepts. This surgical technique combines sinus elevation with a submarginal connective tissue graft. It is indicated in the treatment offered for mild/moderate horizontal and

vertical defects, providing a horizontal and vertical soft tissue augmentation.

Soft tissue augmentation makes it possible to augment up to 3 mm horizontally and vertically 1–2 mm, increase the depth of the vestibule, create an implant-supported crown with proper emergence profiles, and mask the underlying implant-prosthetic structures. Furthermore, the vertical soft tissue augmentation allows the clinical crown of the implant-supported restoration to have a height similar to that of the adjacent natural teeth, favoring esthetics and making hygiene maintenance easier and more accessible for the patient [60].

Whether the implant insertion is performed at the same time as the sinus lift surgery or at a second surgical stage when the bone graft is osseointegrated, this soft tissue augmentation technique can be performed when the implants are in place. When working with a bone-level implant, the transmucosal component will be represented by a healing abutment placed at the same time of the implant insertion (one-stage approach) or at the time of a second surgery (two-stage approach). When a transmucosal implant is placed, the transmucosal portion of the implant allows the coronal displacement from the bone crest of the implant-abutment connection, reducing the risk of further bone resorption and facilitating the patient's hygiene maintenance. Additionally, the transmucosal part of the implant, on top of which a 2–3 mm healing abutment is placed, provides a firm, polished, and convex surface needed for stabilization of the connective tissue graft and of the keratinized tissue of the coronally advanced flap [61].

2.3.1.1 | Flap Design, Flap Elevation. The flap design follows the rules of the coronally advanced flap used in mucogingival surgery for the treatment of multiple gingival recessions. It consists of a scalloped incision in the edentulous area and a vertical releasing incision positioned mesial to the tooth neighboring it [62]. The vertical releasing incision is composed of a 3 mm horizontal incision at the base of the papilla and a vertical incision that reaches the mucogingival line to facilitate the flap elevation up to the antrostomy and the coronal displacement of the flap without disrupting adjacent teeth. The incision in the edentulous area is slightly scalloped and submarginal, considering, on the one hand, to have at least 1 mm of keratinized tissue in the flap and, on the other hand, to leave as intact as possible, the mesial and distal soft tissue that surrounds the peri-implant papillae.

The flap elevation starts then split thickness at the level of the anatomical papillae of the adjacent teeth and at the level of the papillae adjacent to the edentulous site, keeping the incision paramarginal, submarginal and oblique directed towards the center of rotation of the flap, which corresponds to the implant site.

The vertical releasing incision has an elevated split-thickness, keeping the blade parallel to the bone plane, thus leaving. Thus, the periosteum is left to protect the underlying bone in the flap's lateral area of the flap.

To permit the coronal advancement of the flap, all muscle insertions present in the thickness of the flap are removed. This is done by keeping the blade parallel to the external mucosal surface. Coronal flap mobilization was considered “adequate” when the marginal portion of the flap was able to passively reach the palatal tissue, leaving space for the connective tissue graft volume.

Once the flap has been elevated, a microblade is used to mark the outline of the drill hole when using a surgical guide on the crestal soft tissues. By keeping the microblade in contact with the walls of the access hole, a cylindrical portion of soft tissue is traced, which can later be excised full-thickness, delimiting the site where the implant will be placed. This allows access to the crestal bone and the maintenance and maintains the integrity of the “future” mesial and distal implant papillae, which can be de-epithelialized palatally on their occlusal aspect. The presence of mature, wide, and tall anatomical papillae that can be de-epithelialized palatally allows suturing of the graft at the base of the papillae while at the same time leaving a suitable vascular bed coronal to the graft onto which the surgical papillae of the coronally advanced flap can be fixed. This is critical to avoid flap dehiscence and early exposure of the connective tissue graft. Once the supracrestal soft tissues are removed, the implant is placed in an esthetically and prosthetically-guided manner.

In ideal situations, the rough implant surface should be placed 3–3.5 mm apical to the future gingival margin of the prosthetic crown. This area, devoid of buccal bone and with only soft tissue covering the prosthetic components, is called peri-implant transmucosal path. It has been stated that to prevent the formation of soft tissue dehiscence, the soft tissues' thickness of the soft tissues at the level of transmucosal level must be at least 2 mm and have a minimum height of minimum 3 mm. At this point, it is worth questioning if the buccal flap reaches a thickness of 2 mm in its most coronal 3 mm. This does not correspond to the clinical reality in most patients, even those with a thick phenotype. As a result, soft tissue augmentation techniques that include connective tissue grafts must be frequently implemented to obtain the desired 3–3.5 mm thickness of the transmucosal path [63] (Figure 3).

2.3.2 | How to Assess the Difficulty of the Case

Patient selection and proper pre-operative diagnosis is a fundamental step.

Evaluating a patient's facial profile before surgery is crucial, as specific anatomical characteristics can influence the complexity of the procedure. Patients with a short facial profile typically have a thicker sinus wall and a zygomatic process with a more coronal inclination. These features make surgical intervention more challenging than patients with longer facial profiles. Additionally, the size of the patient's mouth, the ease of cheek retraction, and the side of the surgery significantly affect the surgeon's visibility and access to the surgical field.

Moreover, the extent of the edentulous area and the thickness of the lateral wall are vital factors to assess prior to surgery. Generally, short-span edentulism poses more difficulty than long-span edentulism, such as cases involving missing bicuspids

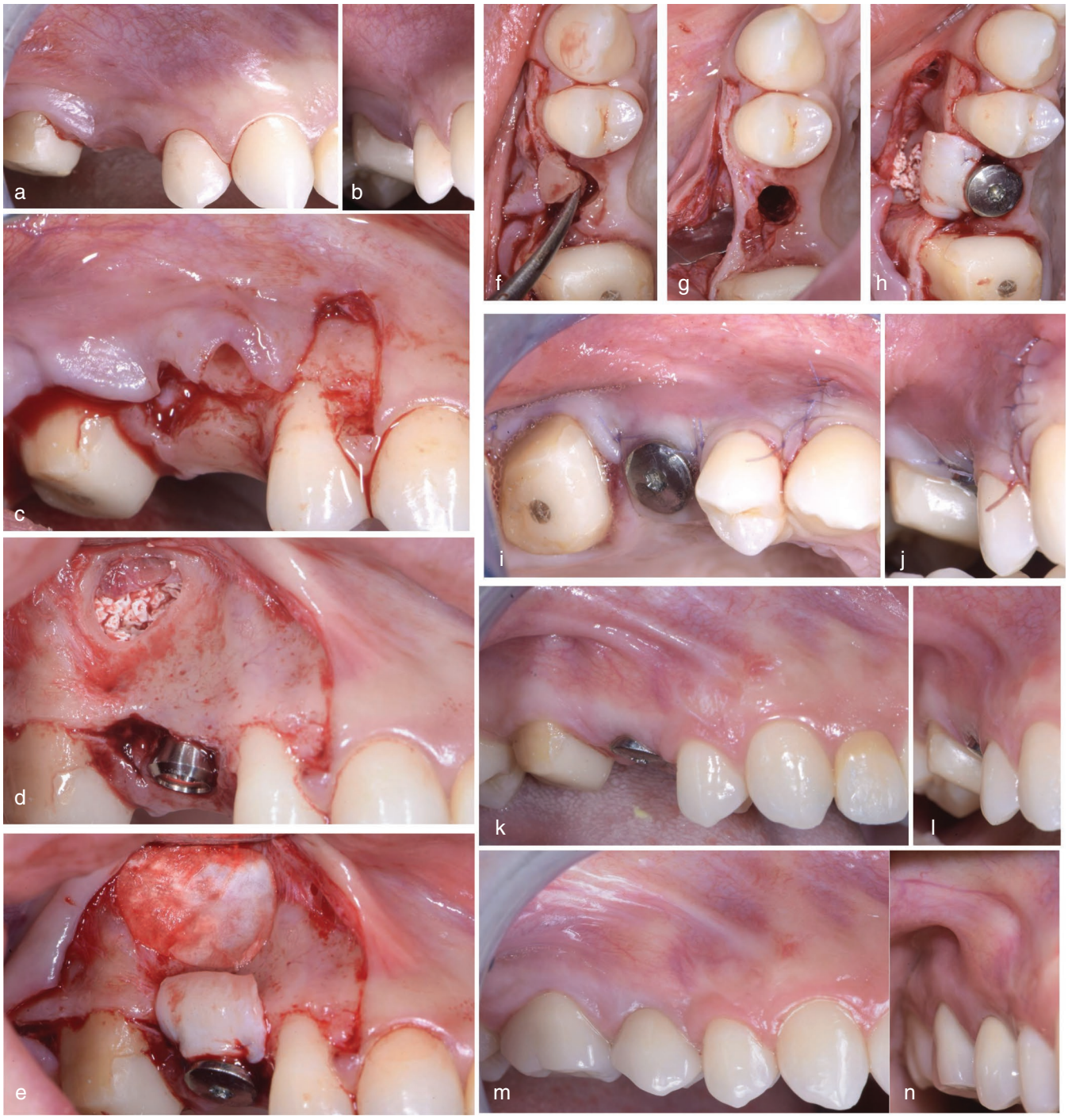


FIGURE 3 | Flap management for lateral window sinus floor elevation. (a, b) Initial situation, lack of soft tissue volume on the vestibular side of the edentulous area; c) Flap design and flap elevation: Scalloped incision in the edentulous area and a vertical releasing incision positioned mesial to facilitate the flap elevation up to the antrostomy and the coronal displacement of the flap without disrupt adjacent teeth; d) Sinus elevation, with lateral antrostomy. Bone grafting was positioned before and after implant positioning to completely fill the space inside the maxillary sinus; e) Pericardium membrane on antrostomy and connective tissue graft, positioned with simple interrupted sutures anchored at the base of the de-epithelialized anatomical papillae; f, g, h) Occlusal view of steps c, d, and e; i) Flap Suture: First intention wound closure between the buccal and palatal tissue both mesial and distal to the implant, a sling suture suspended around the healing screw can be done to further improve adaptation of the keratinized tissues of the buccal flap; j) Once the flap is sutured, the connective tissue graft remains at a position covering the implant's transmucosal portion and serves to keep the buccal flap in a coronal position by reducing its contraction; k) 3-month healing: The keratinized tissues of the former flap are even more coronal with respect to their immediate post operative position; l) a clear demonstration of the improved volume stability provided by the underlying connective tissue graft; m, n) 1 year follow up with final screwed restoration.

and molars. Utilizing three-dimensional radiographs during the preoperative examination provides valuable insights into the thickness of the sinus's lateral wall, the thickness of the sinus membrane, the presence and orientation of sinus septa, the presence and location of the alveolar antral artery, and any bone dehiscence or anatomical variations.

A comprehensive preoperative evaluation and surgical diagnosis allow for an informed assessment of the surgical risks and help determine the required surgical expertise to achieve a successful outcome. The Maxillary Sinus Elevation Difficulty Score worksheet is a tool designed to quantify the difficulty of various clinical scenarios encountered during the procedure (Table 1).

The maxillary sinus elevation, difficulty score worksheet is a tool designed to quantify the difficulty of various clinical scenarios that may be encountered during the procedure.

3 | Surgical Procedures

3.1 | Periodontal Concepts Applied to Implantology

The modern sinus lift flap is a periodontal surgical technique that leverages clinical and biological principles derived from mucogingival surgery. The flap design is an envelope flap, similar to the approach used in coronally advanced flap (CAF) procedures for multiple recession cases.

In this technique, the central axis of rotation is positioned on the canine and extends to the first incisor. Incisions are not made at the sulcus or the apical margin of the recession to preserve the keratinized gingiva apical to the crown or exposed root. This preserved tissue is repositioned over the avascular surface of the tooth after the surgery (Figure 4).

a. At the crestal level, a full-thickness incision is made, either mid-crestal or palatal. Distal to the last tooth, a wide anatomical receiving papilla is created using a divergent incision that extends from the center of the crest towards the distal line angle of the tooth, exiting at the sulcus.
b. (b, c) All surgical papillae are opened using a split-thickness approach, keeping the blade parallel to the root and exiting at the apical probing depth of the sulcus. By bluntly opening several papillae, a larger connective tissue bed is established at the base of the anatomical interdental papillae. This allows for improved repositioning of the primary flap onto a more extensive vascular surface for coronal movement. This technique is particularly advantageous in the presence of adjacent mucogingival recessions, which can be addressed simultaneously (Stefanini et al., 2023c).
c. (d) When adequate surgical visibility is achieved, distal vertical releasing incisions are avoided. If necessary, these incisions are confined to the keratinized tissue or performed as a split-thickness incision in the alveolar mucosa to avoid impacting the muscular sarcolemma, thereby reducing postoperative discomfort.

3.2 | Antrostomy Design

Ensuring optimal access to the sinus cavity during lateral antrostomy is paramount for successful elevation of the Schneiderian membrane in the intended graft location. Several factors merit consideration, including the thickness of the lateral wall, the position of the posterior superior alveolar (PSA) artery, the sinus floor and anterior sinus wall anatomy, internal sinus structures (such as septa and medio-lateral width), and the dimensions of the proposed antero-posterior graft [64].

3.2.1 | Window Size

A larger window facilitates better access for Schneiderian membrane elevation and simplifies instrument navigation around anatomical obstacles like septa. However, extensive removal of the lateral sinus wall may compromise vascular supply to the graft, affecting the percentage of vital bone formation within the sinus over time. While research suggests an inverse relationship between window size and vital bone production, its impact on implant survival remains inconclusive, as the minimal requirement of vital bone for successful osseointegration remains uncertain. Nonetheless, biological considerations remain integral in assessing the chosen technique's efficacy.

3.2.2 | Window Location

The window's placement should balance the need for access and membrane elevation while minimizing intraoperative complications like bleeding and membrane perforation. Studies indicate that membrane perforations are more likely in anatomically restricted areas, such as the narrow anterior sinus portion. An acute angle between the medial and lateral walls at the sinus floor necessitates significant sinus curette manipulation in confined spaces. Locating the window anteriorly allows for direct visual access with less manipulation, while positioning it closer to the sinus floor reduces coronal movements required to reach it. Accordingly, the authors advocate placing the window 3 mm distal to the anterior sinus wall and 2–3 mm coronal to the sinus floor. The window size is then tailored to the internal sinus anatomy and graft dimensions. The presence of a septum should dictate the window's antero-posterior location, preferably straddling the septum to enable safer sinus curette utilization in a lateral to medial direction on both septum aspects. Rotary window techniques often required modifications to safeguard the PSA artery integrity, although piezoelectric techniques offer enhanced vascular protection even during direct work over it.

3.2.3 | Window Design

Throughout the years, various lateral window designs have been proposed, offering distinct advantages. While operator preference may influence the choice, certain designs stand out for their efficacy. These include the elevated hinge, elevated island, island removed, complete osteotomy via osteoplasty, crestal approach, palatal approach, and a novel technique

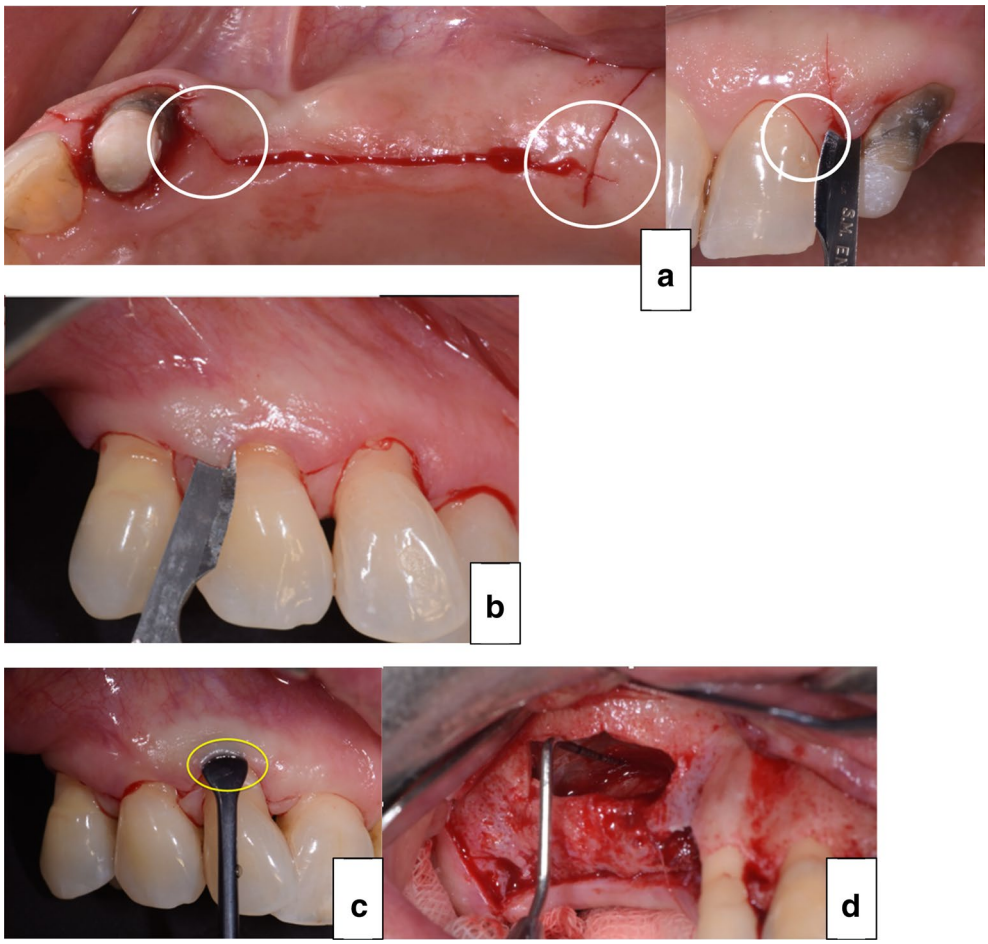


FIGURE 4 | The modern sinus lift flap. The modern sinus lift flap is a periodontal flap that leverages the clinical and biological principles derived from mucogingival surgery. The flap design is an envelope flap similar to the approach used in coronally advanced flap (CAF) surgery for multiple recession cases. In this case, The central axis of rotation is positioned on the canine and extends to the first incisor. No incisions are made at the sulcus or the apical margin of the recession to preserve the keratinized gingiva apical to the crown or exposed root. This tissue will be repositioned over the avascular surface of the tooth at the end of surgery. (a) At the crestal level, the incision is made as a full-thickness cut, either mid-crestal or palatal. Distal to the last tooth, a wide anatomical receiving papilla is created with a divergent incision extending from the center of the crest towards the distal line angle of the tooth, exiting at the sulcus; (b, c) All surgical papillae are opened using a split-thickness approach, keeping the blade parallel to the root and exiting at the apical probing depth of the sulcus. By opening several papillae in a blunt manner, a greater connective tissue bed is created at the base of the anatomical interdental papillae. This allows for better repositioning of the primary flap onto a larger vascular surface for moving it coronally. This is particularly advantageous in the presence of adjacent mucogingival recessions, which can be addressed simultaneously [61]; (d) Where adequate surgical visibility is achieved, distal vertical release incisions are avoided. If necessary, they are confined to the keratinized tissue or performed as a split-thickness incision in the alveolar mucosa to avoid affecting the muscular sarcolemma, thereby reducing post-operative discomfort.

introduced by the authors, termed the simplified antrostomy design (S.A.D.).

The early technique pioneered by Boyne involved complete elimination of the window via osteoplasty using a carbide bur. Subsequently, Wood and Moore introduced the hinge osteotomy in a rotary bur technique. Here, the lateral and coronal osteotomy cuts directly approach the membrane, while the apical cut is partial or consists of small, isolated bone perforations to the membrane level. The window is then fractured by tapping at the coronal aspect, creating a superior hinge. However, caution is necessary during internal elevation to prevent membrane perforation due to sharp edges.

The island osteotomy, a modification of the hinge technique, completes the osteotomy circumferentially with a rotary or piezo device, avoiding tapping to prevent membrane tear. The window can be elevated similarly to hinge osteotomy or removed entirely with a curette.

3.2.3.1 | **Simplified Antrostomy Design.** In classical lateral window elevation technique, a focal point has been the significance of ideal window placement for procedural success. Generally, positioning the window 3 mm from the anterior wall and 3 mm from the sinus floor is advocated to facilitate access to the narrow anterior portion of the sinus, which is often the most challenging area to instrument (Figure 5).

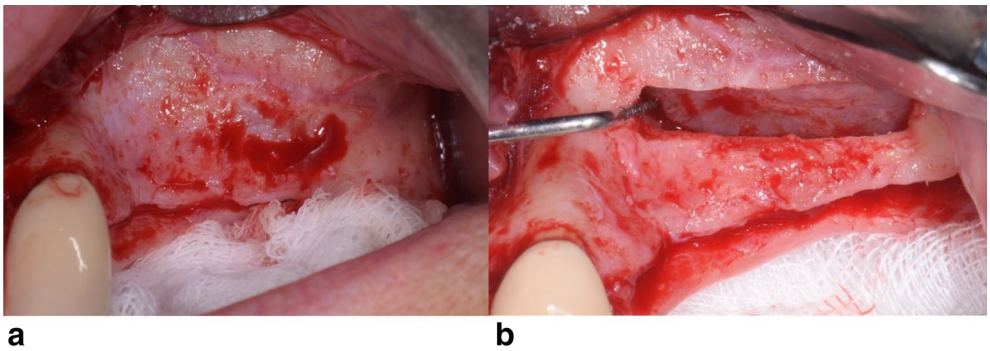


FIGURE 5 | The Simplified Antrostomy design (S.A.D.). This type of antrostomy is indicated when the patient is fully edentulous or has their molars and premolars are missing. A surgical stent could be used help to proper locate the position of the anterior wall of the sinus.

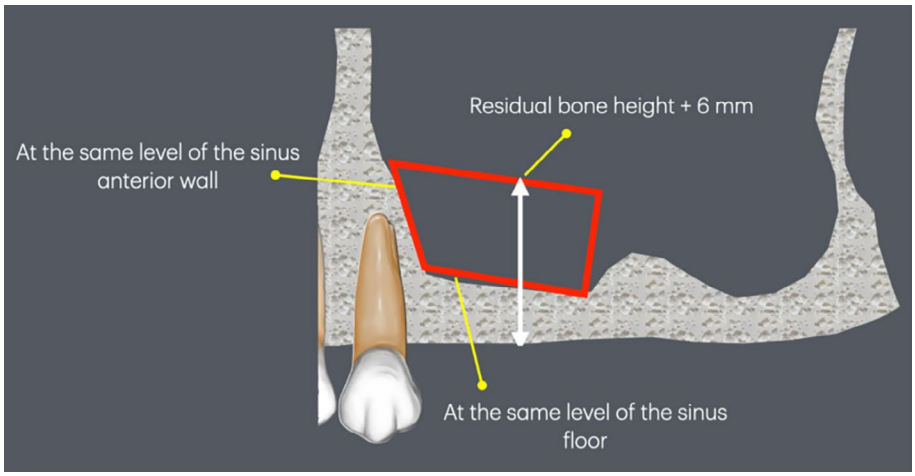


FIGURE 6 | Low Window Antrostomy Design. The low Window antrostomy design is a further refinement of the S.A.D. technique the antrostomy is positioned as low and as mesially as possible, the low window design offers potential benefits in reducing the risk of sinus membrane perforation.

A modification of the lateral window procedure, as presented by Testori et al. for use in the All on Four procedure, introduced a small sinus elevation against the anterior wall to enable greater posterior implant tilting, thereby enhancing the anterior–posterior spread. This technique, requiring only a small window, initiated at the anterior wall instead of starting distally and reaching forward. Proven to be straightforward and reproducible, it became a viable starting point for most lateral window procedures, with the window expandable as needed to accommodate varying internal sinus anatomy.

The S.A.D. entails a three-step procedure:

1. Utilize precise CBCT and clinical measurements to create a small window, measuring 3 mm wide by 6 mm long, just distal to the anticipated location of the anterior sinus wall.
2. Extend the window anteriorly (mesially) to identify the anterior sinus wall.
3. Enlarge the antrostomy distally as dictated by internal anatomy (e.g., septa) and the number of implants planned. Coronally extend to be 2–3 mm from the sinus floor and approximately 10 mm in the anterior–posterior direction.

3.2.3.2 | Low Window. The low window antrostomy design represents a further refinement of the simplified antrostomy technique. In this approach, the window is positioned as low and as mesially as possible. The lower osteotomy line is consistently placed flush with the sinus floor, while the mesial line aligns flush with the anterior wall of the sinus. Moreover, the window's height is limited to 6 mm to prevent interference with intraosseous anastomosis. The placement of the distal osteotomy corresponds to the position of the most distally planned implant.

This specific osteotomy design offers distinct surgical advantages. By positioning the lower horizontal osteotomy flush with the sinus floor, any residual bone wall that might impede sinus membrane detachment is eliminated. The placement of the distal osteotomy line is optimized based on the planned position of the most distal implant. Extending it beyond this point provides no additional benefit and may lead to the elevation of a wider mucoperiosteal flap (Figure 6).

The low window design offers potential benefits in reducing the risk of sinus membrane perforation, especially in cases where the patient's sinus angles are narrow. By positioning the lower osteotomy line flush with the sinus floor and the mesial line flush with the anterior sinus wall, this design enhances surgical access and minimizes blind detachment of the membrane. The 6 mm window height strikes a balance, allowing for easy membrane elevation without hindrance. A smaller

height would impede membrane elevation, while a larger one would necessitate a wider mucoperiosteal flap without significant advantages. This design facilitates access to the anterior sinus recess, typically the most challenging area for membrane detachment. Overall, the low window design presents a refined approach to lateral antrostomy, potentially reducing the risk of sinus membrane perforation even in patients with narrow sinus angles.

3.2.4 | Rotary Window Preparation

Boyne's 1980 case introduced maxillary sinus elevation with window preparation using a laboratory-sized carbide bur, later modified with low-speed implant motors and eventually high-speed air-turbine drills. While rotary instrumentation has been successful, complications such as bleeding (2%–4%) and membrane perforation (20%–25%) are relatively high due to the instrument's inability to differentiate between hard and soft tissues. The introduction of piezoelectric surgical techniques has significantly reduced these complications by selectively cutting hard tissues without damaging adjacent soft tissues.

3.2.5 | Piezoelectric Window Preparation

Piezoelectric techniques utilize low frequency ultrasonic vibrations to selectively cut hard tissues while preserving adjacent soft tissues. This technique has shown efficacy in maintaining the integrity of the internal branch of the PSA artery and the Schneiderian membrane during maxillary sinus elevation, with perforation rates ranging from 3.6% to 5%, compared with 20%–25% with rotary techniques. The unique ultrasonic elevator provides circumferential internal membrane release, enhancing safety. Two protocols exist: an outlining technique for thinner lateral walls and an osteoplasty technique for thicker walls. Osteoplasty has shown the lowest perforation rates, particularly in cases with thick lateral walls (Figure 7).

3.3 | Regenerative Procedures

3.3.1 | Membrane Elevation

Membrane elevation spans a spectrum from relatively straightforward to exceedingly challenging, contingent upon numerous anatomical and procedural considerations.

The initial entry into the sinus during membrane elevation poses a potential challenge. There is a risk of the elevator rolling over the membrane, compressing it against the internal sinus wall, and causing a tear, particularly when using dull elevators. However, this risk is mitigated using piezoelectric "trumpet-shaped" elevators, which, when operated at a low power setting with a cavitating water spray, yield a predictable circumferential membrane separation of approximately 2 mm. This facilitates subsequent elevation without the risk of roll-over perforation. Additionally, membranes with a thickness of ≤1 mm have a significantly higher perforation

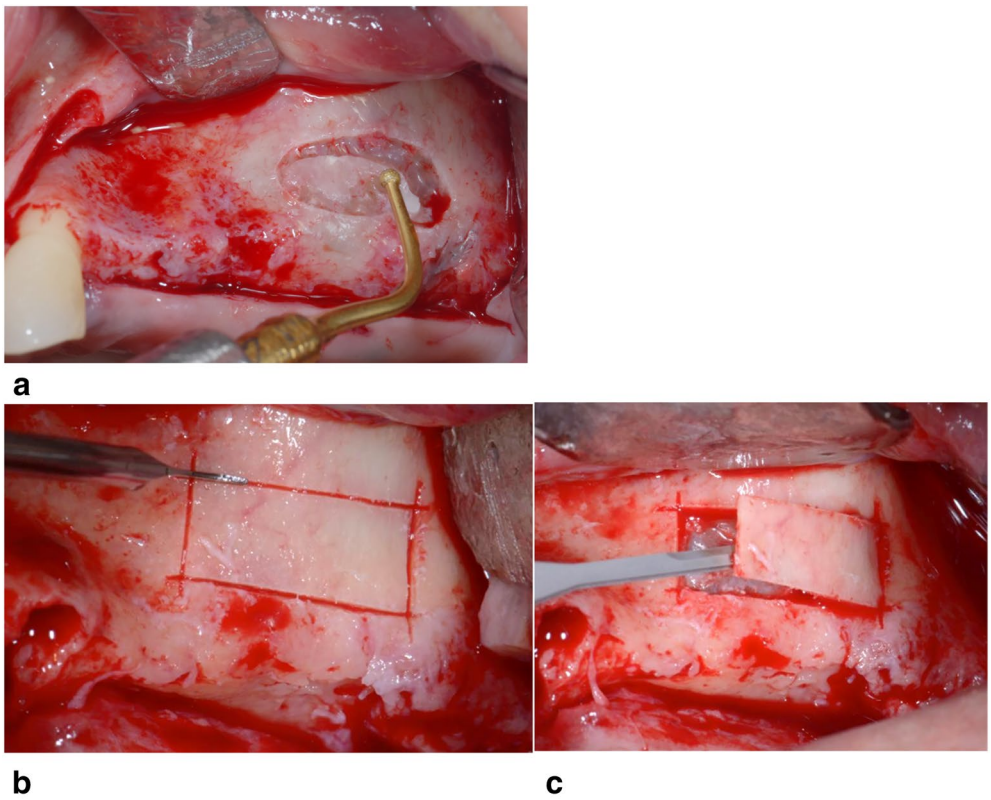


FIGURE 7 | Piezoelectric antrostomy design. The antrostomy could be made with a traditional oval shape by using diamond coated piezoelectric inserts, or it could be made with a rectangular shape with overlapping angular cuts by means of a piezoelectric saw. This technique is faster but could lead to delamination or perforation of the sinus membrane.

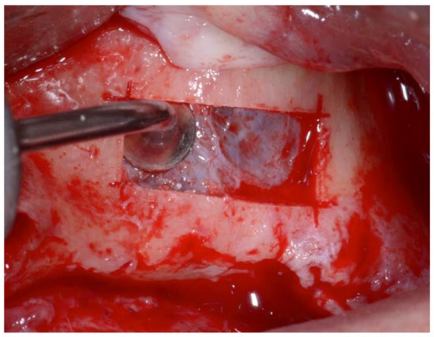
rate, underscoring the importance of careful and precise elevation technique, especially with thin membranes.

Elevation should progress from lateral to medial, utilizing either 45° or 90° piezoelectric sinus elevators, or hand elevators. Sharp elevators are preferred over dull ones to avoid roll-over and tearing of the membrane. When adhesions of the membrane are encountered on the sinus floor, a sharp periodontal knife like the Goldman-Fox knife may be employed. It is crucial to always maintain direct contact with the bone surface when using sharp elevators to prevent membrane perforation.

When elevating the membrane from septa, it is advisable to gain window access to both sides of the septum (anterior and posterior) to facilitate lateral-to-medial elevation instead of an anteroposterior direction. This approach minimizes the challenge of keeping the elevator in contact with bone while moving over a sharp septal spine. Slow, sequential medial movement from each side ensures effective membrane elevation (Figure 8).

In the event of a perforation, proceeding cautiously with membrane elevation is advisable. It is crucial to avoid the direct area of the perforation, as it represents a weak spot where further disturbance may lead to its expansion. Instead, continue the elevation at a distance from the perforation, possibly circumventing it entirely. With this approach, you may observe the perforation diminishing in size as tension on the membrane is relieved by the additional release.

Another strategy to facilitate further elevation is to cover the perforation with a collagen membrane or L-PRF membrane if available, can effectively stabilize the tear. The rough texture of these membranes or the tackiness of L-PRF membrane aids in adherence and promotes stability, assisting in the continuation of membrane elevation.



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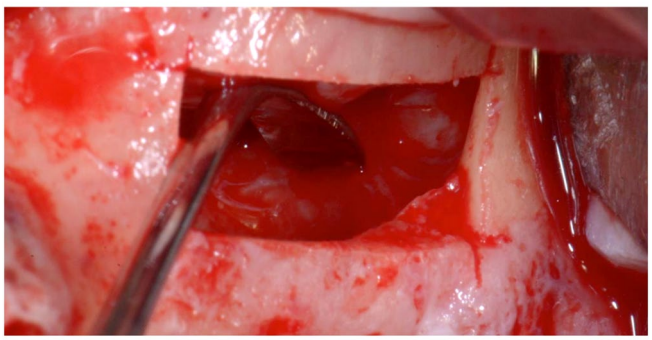

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FIGURE 8 | Window elevation. The elevation of the sinus membrane begins with the use of a trumpet-shaped piezoelectric insert. During this phase, it is crucial to reduce the water flow intensity, as excessive water pressure can cause perforation of a thin sinus membrane. The membrane should be carefully detached until the medial wall of the maxillary sinus is reached. Once elevated, a resorbable membrane should be applied to protect the sinus membrane.

3.3.2 | Grafting

When placing particulate grafts into the sinus cavity, ensuring complete filling of the space without leaving voids is crucial. Osteoconductive graft materials are preferable as they provide better space maintenance than blood clots, aiding in volume retention. However, the impact of packing pressure on eventual volume requires consideration. While direct evidence is lacking, volumetric studies indicate a loss of graft volume over time, even with supposedly non-resorbable graft materials such as xenografts, with observed losses of up to 10%. It is conceivable that some volume loss may stem from graft compression due to intra-sinus pressure. Smaller graft particles are more susceptible to compression than larger ones, potentially resulting in volume loss and compromised inter-particular space. Studies comparing vital bone production with xenografts of varying particle sizes suggest that larger particles promote greater vital bone formation due to reduced compression and preserved inter-particular space, facilitating vascular ingrowth and bone formation while maintaining volume [65].

However, there are potential drawbacks associated with large graft particles, particularly in cases of inadequate perforation repair. Escaped large graft particles could obstruct the ostium, leading to postoperative sinusitis or infection. Therefore, careful consideration of graft particle size and thorough perforation repair is essential to mitigate such risks (Figure 9).

In clinical settings, there appears to be no significant difference in implant survival rates between the two techniques in the short term [66].

3.3.3 | Suture

The suture of the flap started with a interrupted periosteal suture performed at the most apical extension of the vertical releasing incisions; then, it proceeded coronally with other interrupted sutures, each of them directed, from the flap to the adjacent buccal soft tissue, in the apical–coronal direction. This was done to facilitate the coronal displacement of the flap and to reduce the tension on the last coronal sling suture. The sling suture around the mesial tooth permitted to stabilize the surgical papillae over the inter-dental connective tissue bed and allowed for a precise adaptation of the flap margin over the underlying convexity of the crown. A series of simple interrupted sutures allow first intention wound closure between the buccal and palatal tissue, both mesial and distal to the implant, a sling suture suspended around the healing screw can be done to further improve the adaptation of the keratinized tissues of the buccal flap.

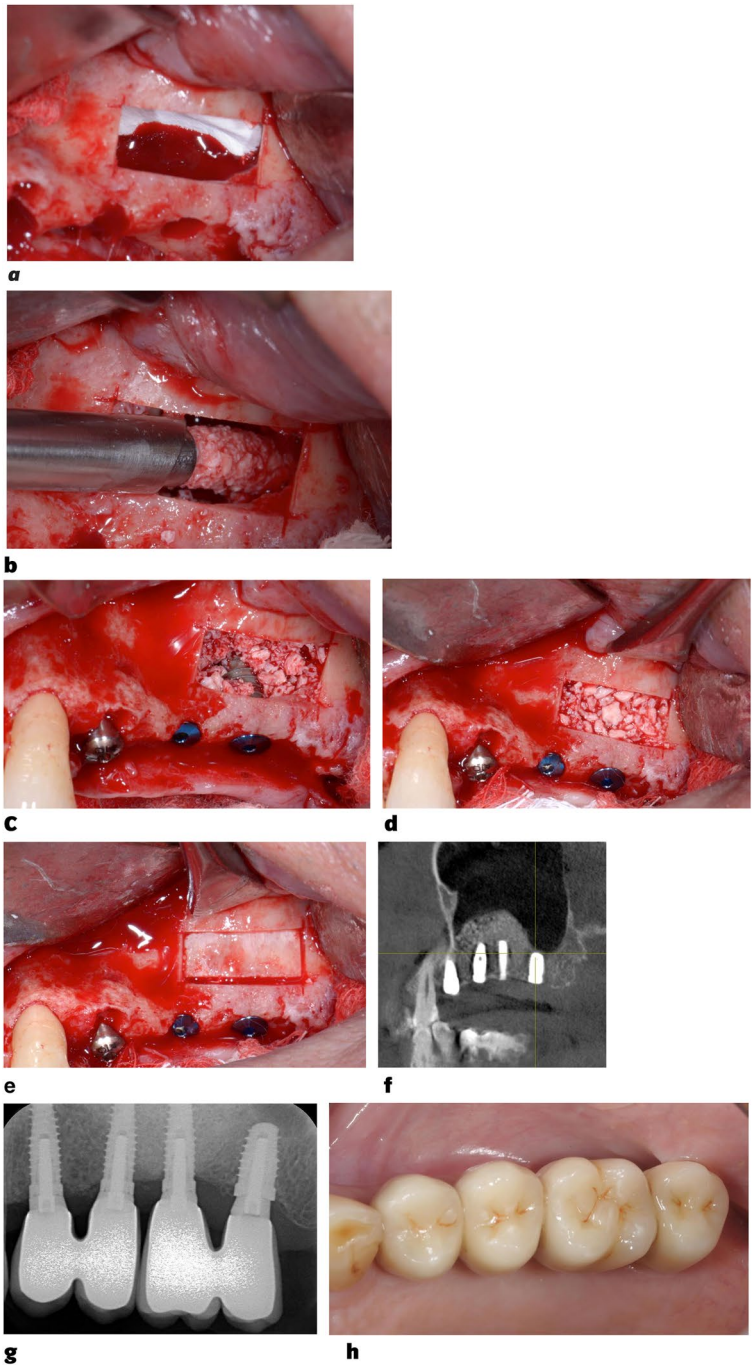

FIGURE 9 | (a) a membrane is placed as a new superior wall to help contain the placed compressed bone graft; (b) The bone graft should be introduced into the sinus cavity under the most sterile conditions. Using a carrier to reduce the risk of graft infection; (c, d) If implant placement is planned during the same surgical phase, the graft should be applied to the anterior, posterior, and medial regions of the sinus, filling approximately two-thirds of the cavity. The implants are then placed, and the remaining graft material is added to complete the filling. (e) At the end of the grafting procedure a resorbable membrane could be placed over the antrostomy to prevent graft migration, reducing soft tissue ingrowth, and supporting bone formation. Another option is to reposition the bone lid removed during a lateral sinus lift procedure. This method aims to act as a natural barrier, encouraging osteogenesis, or new bone formation, by maintaining the autogenous bone's osteoconductive properties. (f) CBCT showing the post operative result; (g) Peri-apical radiographs at follow-up after implant loading; and (h) final restoration at follow-up. In clinical settings, there appears to be no significant difference in implant survival rates between the two techniques in the short term [65].

3.4 | Pre and Post—Op Pharmacological Regimen

Prophylactic procedures are generally used to prevent the onset of post-operative infections after sinus floor elevation [67]. The medical therapy mainly consists of antibiotics, associated or not with further medications.

The choice of antibiotics presents considerable variability not only for the type but also for the dosage and route of administration. Given the absence of precise guidelines, the clinical decision can be empirical or influenced by expert opinion. A recent systematic review of the literature has shown that the most widely used class is represented by oral penicillin derivatives

(amoxicillin in association with clavulanic acid 875–125 mg) due to its broad spectrum. At the same time, in allergic patients, the first choice may be ciprofloxacin [68] or doxycycline [69]. Interestingly, amoxicillin alone does not appear to be able to provide sufficient antibiotic prophylaxis, probably due to growing antibiotic resistance [70]. The use of clindamycin, however, seems to be strongly discouraged by most experts due to its side effects [71]. The duration of therapy should be extended for at least 7–8 days. A clinical consensus [72] suggested using amoxicillin and clavulanic acid (1 g) twice a day orally starting from the day before surgery and for the following 7 days. For allergic patients, the panel of experts recommended the combination of Clarithromycin (250 mg) and Metronidazole (500 mg) for 7 days.

In addition to antibiotic therapy, corticosteroids are often used immediately and not before surgery to reduce post-operative edema [73]. The most used route of administration is intramuscularly. Even in this case, the choice of the duration of therapy is often dictated by clinical experience or expert opinion. Nasal decongestants are usually indicated for sinusitis management [74].

4 | Conclusions

The lateral window sinus elevation procedure has stood the test of time, demonstrating remarkable success as a pre-prosthetic surgical intervention over the past four decades, as evidenced by multiple reviews. Despite predictions in the early 2000s that advancements such as the transcrestal approach would render it obsolete, the lateral window procedure remains relevant. This is particularly true considering the challenges posed by tilted and short implant placements in the posterior maxilla and the diverse variations of transcrestal approaches.

While options like the transcrestal approach tilted and short implants offer less invasiveness and high success rates, the lateral window procedure has also become less invasive and more accessible. It has transitioned from a hospital-based procedure reliant on autogenous bone harvest to an office-based procedure with no need for donor bone harvesting. Techniques utilizing smaller access windows and flaps have further minimized procedure-related morbidity.

Despite the emergence of alternative techniques, the lateral window approach boasts unique advantages. It provides greater access to work around obstacles like septa, enables single-surgery management of multiple implant sites, and is applicable regardless of residual crestal bone height. Moreover, in the event of procedural complications such as membrane perforations, it offers the flexibility to address them during the same procedure.

It is essential not to be swayed by educational background or personal preference when selecting treatment modalities, as this may lead to inappropriate patient management. To be considered a comprehensive provider of regenerative services, one must be proficient in various techniques and capable of delivering the most suitable therapy for each case. Consequently, indications for the lateral window approach will persist, ensuring its continued relevance in implant dentistry.

Author Contributions

Riccardo Scaini: conceptualization, methodology, investigation, writing – original draft, project administration. **Muhammad H. A. Saleh:** writing – review and editing, supervision. **Hong-Chang Lai:** writing – original draft. **Matteo Sangiorgi:** writing – original draft. **Giovanni Zucchelli:** supervision. **Tiziano Testori:** conceptualization, methodology, supervision, project administration.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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