

Lateral Sinus Augmentation Vol 1.

Sinus Anatomy

1. **AK** J P van den Bergh, C M ten Bruggenkate, F J Disch, D B Tuinzing Anatomical aspects of sinus floor elevations Clin Oral Implants Res. 2000 Jun;11(3):256-65.

Review of procedure

2. **TV** Wallace SS, Tarnow DP, Froum SJ, Cho SC, Zadeh HH, Stoupel J, Del Fabbro M, Testori T. Maxillary sinus elevation by lateral window approach: evolution of technology and technique. J Evid Based Dent Pract. 2012 Sep;12(3 Suppl):161-71.
3. Valentini P, Artzi Z. Sinus augmentation procedure via the lateral window technique- Reducing invasiveness and preventing complications: A narrative review. Periodontology 2000. 2023;91:167–181. DOI: 10.1111/prd.12443
4. **CM** Testori T, Weinstein T, Taschieri S, Wallace SS. Risk factors in lateral window sinus elevation surgery. Periodontol 2000. 2019 Oct;81(1):91-123. doi: 10.1111/prd.12286.

Pre-op assessment

5. Torretta S, Mantovani M, Testori T, Cappadona M, Pignataro L. Importance of ENT assessment in stratifying candidates for sinus floor elevation: a prospective clinical study. Clin Oral Implants Res 2013 ; 24 (Suppl A100): 57 - 62 .
6. Shanbhag S, Karnik P, Shirke P, Shanbhag V. Cone-beam computed tomographic analysis of sinus membrane thickness, ostium patency, and residual ridge heights in the posterior maxilla: implications for sinus floor elevation. Clin Oral Implants Res. 2014 Jun;25(6):755-60.
7. Janner SFM, Dubach P, Suter VGA, Caversaccio MD, Buser D, Bornstein MM. Sinus floor elevation or referral for further diagnosis and therapy: A comparison of maxillary sinus assessment by ENT specialists and dentists using cone beam computed tomography. Clin Oral Implants Res. 2020 May;31(5):463-475.
8. **MS** Falco A, Amoroso C, Berardini M, D'Archivio L. A retrospective study of clinical and radiologic outcomes of 69 consecutive maxillary sinus augmentations associated with functional endoscopic sinus surgery. Int J Oral Maxillofac Implants. 2015 May-Jun;30(3):633-9.
9. **AK** Niu L, Yu H, Wang J, Tang Y, Qiu L. Does a Severely Resorbed Subantral Ridge Decrease Long-Term Implant Survival Rate with Sinus Floor Augmentation? Int J Oral Maxillofac Implants. 2022 Sep-Oct;37(5):905-912.
10. **TV** Testori T, Yu SH, Scaini R, Rosano G, Tavelli L, Del Fabbro M, Francetti L, Wang HL. Split-Thickness Flap for the Management of a Maxillary Sinus Wall Bony Fenestration During Lateral Window Sinus Augmentation: Case Reports and Technical Surgical Notes. Int J Periodontics Restorative Dent. 2022 May-Jun;42(3):311-318.

Instrumentation

11. Atieh MA, Alsa Beeha NH, Tawse-Smith A, Faggion CM Jr, Duncan W. Piezoelectric surgery vs rotary instruments for lateral maxillary sinus floor elevation:

a systematic review of and meta- analysis of intra- and postoperative complications . Int J Oral Maxillofac Implants . 2015 ; 30 : 1262 – 1271

Lateral window dimensions

12. **CM** Avila-Ortiz G , Wang HL , Galindo-Moreno P , Misch CE , Rudek I , Neiva R . Influence of lateral window dimensions on vital bone formation following maxillary sinus augmentation . Int J Oral Maxillofac Implants . 2012 ; 27 : 1230 - 1238 .
13. **VX** Zaniol T, Zaniol A, Ravazzolo S, Testori T, Wallace SS. Low Window Sinus Elevation Technique: Bone Gain and Postsurgical Discomfort. A Retrospective Case Series. Int J Periodontics Restorative Dent. 2022 Jul-Aug;42(4):449-457.

Mucous retention cysts

14. Yu H, Qiu L. Histological and clinical outcomes of lateral sinus floor elevation with simultaneous removal of a maxillary sinus pseudocyst. Clin Implant Dent Relat Res. 2019 Feb;21(1):94-100.
15. Qiu L. Histological and clinical outcomes of lateral sinus floor elevation with simultaneous removal of a maxillary sinus pseudocyst. Clin Implant Dent Relat Res. 2019 Feb;21(1):94-100.

Sinus Anatomy

Topic: sinus anatomy

Authors: J P van den Bergh, C M ten Bruggenkate, F J Disch, D B Tuinzing

Title: Anatomical aspects of sinus floor elevations

Source: Clin Oral Implants Res. 2000 Jun;11(3):256-65.

DOI: 10.1034/j.1600-0501.2000.011003256.x

Reviewer: Amber Kreko

Type: review

Keywords: anatomy, maxillary sinus, sinus lifting, sinus floor elevation, bone grafting

Purpose: To discuss anatomical aspects of sinus floor elevations

Discussion:

- First introduced by Tatum in 1976; First published by Boyne then Tatum
- Classic sinus lift: top hinge door in lateral maxillary sinus, door is luxated inward and upward with Schneiderian membrane to a horizontal position forming new sinus bottom. Space underneath door and sinus mucosa is filled with graft material. Implants can be inserted simultaneously when there is sufficient bone height for primary stability (greater than 4mm)
- Anatomy of the maxillary sinus
- Surgical considerations with regard to the anatomy

- Flap design
 - Incision made on top of alveolar ridge, or slightly palatal through keratinized attached mucosa to allow for sufficient overlap and wound closure.
- Infra-orbital foramen
 - Preparation of door may be threat to neuro-vascular bundle.
 - Mechanical damage by wound retractor should be regarded.
 - May happen when the door is too high, too large for width of sinus, or very narrow sinuses.
- Sinus floor
 - Shape of door should ideally follow inner shape of maxillary sinus with rounded corners to reduce the chance of damaging the Schneiderian membrane.
 - Sinus wall is thin and looks greyish-blue.
- Lateral sinus wall preparation
 - Door should be wide enough to handle instruments in areas where bone is thin. Start with large round steel burr and finish with large round diamond burr that can not easily damage the membrane or perforate bon wall.
 - Healthy membrane is greyish blue. Smokers may look atrophic and extremely thin. Chronic sinusitis has thick, spongy membrane and may be a contra-indication.
 - Door luxation is best performed with finger pressure to feel resistance and fracture of door hinge and prevent short instrument from perforating sinus mucosa

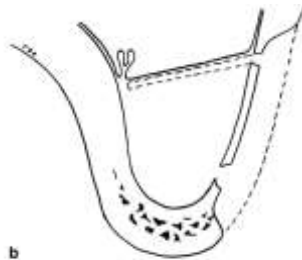


Fig. 2.1a, b) Clinical picture and schematic drawing of thinning out a thick bony sinus wall in order to acquire favourable conditions for preparation of the door and Schneiderian membrane.

- Schneiderian membrane
 - Sinus membrane should be sufficiently lifted using sinus floor elevation instruments.
 - Start from caudal ede and work towards the mesial and distal side. When whole caudal membrane is prepared, the door can be lifted.
 - Overfilling may cause necrosis of Schneiderian membrane.
 - Previous sinus surgery sometimes a contra-indication due to scar tissue and traumatic bone loss so sinus mucosa is in immediate contact with oral mucosa.
- Schneiderian membrane perforations
 - When small and located in area of mucosa folds, no other measurement taken
 - When larger and located in unfavorable area, perforation needs to be closed. Resorbable membrane is used to cover the defect.
 - When really large, sinus lift should be abandoned.
 - Re-entry can be considered – wait 6-8 weeks after first surgical attempt.
- Maxillary sinus septa
 - Incidence varies between 16-58%.
 - Door can be W-shaped or two trap doors done to avoid septum.
 - Another option is removing the septum (partially)
- Narrow sinus

- One way to get around is do antrostomy on lateral sinus wall instead of door but sturdy bone support and new bottom of sinus will be absent
- The door can also be converted to a hatch mobilized on all 4 sides and carefully lifted upward to a higher position in maxillary sinus where lateral sinus dimensions are larger



-
- Para-nasal ostium
 - High position of ostium means drainage of sinus is not likely to be blocked mechanically. Clinical evidence for changed antral mucosal function can not be found
- Hemorrhages
 - Blood supply from: infra orbital artery, posterior superior alveolar artery, and greater palatine artery
 - Hemorrhages are rare. Small vessels might be damaged and should be left to stop spontaneously or stopped by slight gauze pressure.
 - Electro-surgery will cause necrosis
- Bone grafting, bone healing, and remodeling
 - Amount of graft material varies
 - Healing and remodeling depends on vascularization of Schneiderian membrane and buccal muco periosteal flap and bone segments of former sinus floor and elevated lateral sinus wall
- Primary alveolar bone height and width
 - Literature recommends at least 4mm of bone height to place implants simultaneously. Essential is the primary stability of the implant. Literature recommends at least 4 mm of bone height of the original alveolar process for a one stage procedure.
 - If insufficient bone quality or quantity, implant should be placed 4 to 6 months after sinus floor grafting.
 - Minimal width of 5mm is also needed.
- Implant surgery
 - Anatomy after sinus floor elevation is favorable for implant surgery.
 - Elevated sinuses can allow for implants with a length of 12mm
 - In cases of atrophic bone, additional local augmentation may be needed

Review of procedure

Topic: Lateral window sinus membrane elevation

Authors: Wallace SS, Tarnow DP, Froum SJ, Cho SC, Zadeh HH, Stoupel J, Del Fabbro M, Testori T

Title: Maxillary sinus elevation by lateral window approach: evolution of technology and technique

Source: J Evid Based Dent Pract. 2012 Sep;12(3 Suppl):161-71

DOI: 10.1016/S1532-3382(12)70030-1

Reviewer: Tam Vu

Type: Review

Keywords: maxillary, sinus, augmentation, elevation, techniques, evolution, grafting, piezosurgery, DASK

Purpose: to review the evolution of technology and technique used in maxillary sinus elevation by lateral window approach

Discussion:

Evolution of Grafting Materials

- **Autogenous** use to be gold standard, now, reviews show bone replacement grafts results in more favorable outcomes, with higher implant survival rates
 - Advantage: reduce graft maturation time
 - Disadvantage: increased morbidity and sig graft resorption
- **Xenografts** are successful, 3 factors:
 - Osteoconductive, ~25% vital bone formation at 6-8 months
 - Not resorbed, adds ~25% to mineral content
 - Residual graft material never seen in direct contact with implant surface – does not interfere w/osseointegration
- Histology of xenografts presents with bone bridging: residual particles of xenograft are joined to and surrounded by new vital bone
- Bone morphogenetic proteins (BMPs) accelerates resorption of allograft material – less favorable
- Platelet-rich plasma – does not enhance outcomes
- **Recombinant human platelet-derived growth factor $\beta\beta$ (rh- PDGF $\beta\beta$)** – shows above-average vital bone formation and earlier bone formation
 - 21.1% w/BioOss + rh-PDGF $\beta\beta$
 - 11.8% w/BioOss alone
- No graft (tenting) – implant support membrane, bone formation via blood clot
- **BL:**
 - Rough-surfaced implants are more favorable than machined
 - Bone replacement grafts can be substituted for autogenous with similar or more favorable outcomes
 - Placement membrane over window results in increased implant survival rate
 - Simultaneous and delayed implant placement have similar survival rates

Evolution of Surgical Technique

- Original - rotary technique w/surgical hand piece or high-speed hand pieces
- Modifications:
 - Hinge osteotomy
 - Piezoelectric technique
 - Dentium Advanced Sinus Kit (DASK)
 - Transcrestal approach (osteotomes, safe-cutting drills, hydraulic pressure, piezo, balloon elevation)
- Modifications are designed to increased predictability of procedure and reduce 2 main complications:
 - Profuse bleeding
 - Sinus membrane perforation

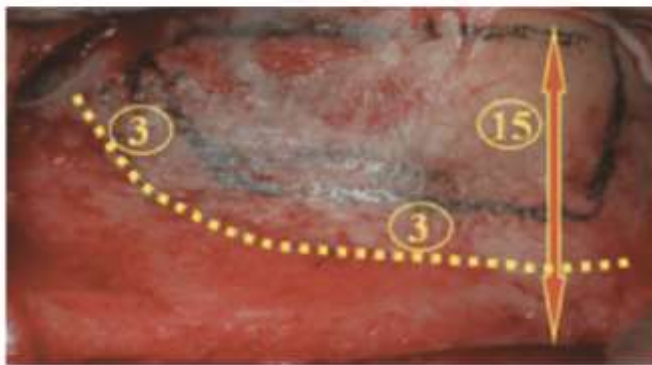
Flap Entry

- visualization and access via full-thickness flap originating from midcrestal area or slightly palatal (sinus floor close to crest or minimal KG)

Antrostomy Techniques

- Goal: gain access to elevate Schneiderian membrane
- Larger windows should be considered when we expect difficult elevation (septa, membrane adhesion, narrow lateral to medial dimension, v-shaped medial walls, and preexisting lateral wall defects)
- Position:
 - ~ 3 mm from sinus floor
 - ~3 mm from anterior wall
 - Superior border is 15 mm from crest

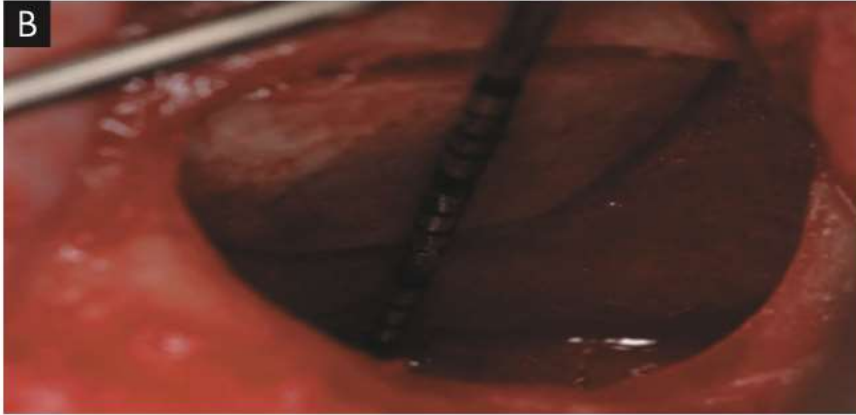
Figure 2. Window location 3 mm from sinus floor, 3 mm from anterior wall.



- Vascular supply mainly from bony walls and not from Schneiderian membrane (important to elevator up medial wall to level of proposed graft placement)

Rotary Technique

- High speed/surgical hand piece + round diamond bur
 - Cutting motion: lateral motion (rather than up-and-down, which is more likely to cause membrane perforation)
- Hinge technique/partial osteotomy: superior osteotomy partially cut and window rotated inwards and upwards

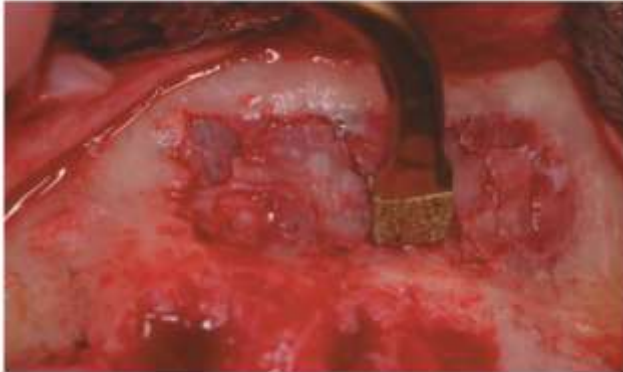


- Complete osteotomy/"island": osteotomy 360°, remain attached to and elevated with membrane

Piezoelectric Technique

- Low frequency ultrasonic vibration
- Eliminates "drag" created by rotary instrumentation, less likely to damage blood vessels or Schneiderian membrane
 - Studies report 3.6 – 5.0% perforation rate with Piezo (20 – 25% with rotary)

Figure 9. Piezoelectric osteotomy insert in place to refine antrostomy.



DASK Technique

- To reduce soft tissue complications
- Perforation rate: 5.8%
- Uses 6- or 8-mm diameter x 4-mm high dome shaped drill with nonaggressive diamond grit + internal & external irrigation
- Drilling at 800 – 1200 rpm, little to no "drag"
- Light pressure drilling to plane/thin bone
- Thin bony layer and membrane elevated together

Figure 12. An 8-mm DASK drill on sinus wall.



Conclusion: Evolution of surgical techniques in sinus membrane elevation is to reduce complication rates and improve clinical outcomes. Success rates usually determined via implant survival, which is >90% when used with rough-surfaced implants, xenogeneic bone grafts, and membrane over the window.

Topic: Lateral Sinus Lift (Review of Procedure)

Authors: Valentini P, Artzi Z.

Title: Sinus augmentation procedure via the lateral window technique-Reducing invasiveness and preventing complications: A narrative review

Source: Periodontol 2000. 2023 Feb;91(1):167-181.

DOI: 10.1111/prd.12443. Epub 2022 Aug 4.

Reviewer: Daeoo Lee

Type: Narrative review

Keywords: sinus, augmentation, lateral window, invasiveness, complications

Purpose: Describes different Lateral Window Osteotomy (LWO) methods, decision tree, anatomical structures.

Discussion:

- Surgical assessments of the LWO technique
 - Incision (Full mucoperiosteal crestal incision + vertical release VS. horizontal vestibular full thickness)
 - Pt. favors vestibular incision in terms morbidity
 - Vertical releasing incision may cause numbness due to presence of terminal branches of the infra orbital nerve
 - Blunt dissection via Metzenbaum scissor may avoid this issue
 - Triangular flap without any releasing incision may also avoid this issue
 - Antrostomy
 - Hinged door/window in the lateral osseous wall of the antrum. Moveable bony plate rotated inward/upward with the Schneiderian membrane.
 - Reports of Piezo tips are safer than diamond bur to avoid perforation
 - Full antrostomy approach of bony lid completely removed (fully exposing the Schneiderian membrane)

- Allows better control of the Schneiderian membrane structural integrity, easy biomaterial grafting application and its distribution and, thus, would prevent unnecessary intra- and post-operative complications
 - Diamond bur, piezo, Dentium kit
 - Minimally invasive (5-6mm circular window)
 - Piezo
 - High implant placement success rate with very low complication rate
 - Endoscopic
 - Need a team
 - Endoscope inserted through a punctured maxillary sinus wall in the canine
- Surgical Decisions
 - One or 2 stage (whether to combine implant placement)
 - Factors
 - Implant stability (Residual bone, width and height, its density, ie, its resistance to drilling during implant site preparation)
 - Grafting bio-materials
 - Raghoobar et al.: No differences in regard to implant function SR between native bone and augmented sinus, nor between simultaneously vs delayed implant placement in the augmented sinus, and neither in regard to the different grafting biomaterials, autogenous and non-autogenous.
 - Grafting Technique
 - Syringe technique
 - Grafting material must be in direct contact with bone to avoid gaps
 - Application of the GTR membrane coverage in the LWO
 - Meta-analysis: membrane covered vs non-covered sites (32.4% vs 33.1%)
 - Applying membrane controversial in regards to GTR concept
 - Improvement of graft stability by preventing its lateral displacement due to nose blowing, sneezing, diving, etc.
- Anatomical Considerations
 - Schneiderian membrane preservation
 - Narrow the sinus, the higher the membrane perforation rate
 - The window should be placed as close as possible to anterior wall
 - Membrane perforation correlates to thicker lateral walls, larger windows, existing sinus pathology.
 - Perforation rate 20-60% (30% average)
 - Other factors: Smoking, thin sinus membrane (.15mm or less), irregular, narrow tapered, and tapering sinus contours, presence of septa, quality of elasticity.
 - No conclusive data but thicker membrane seems to be more prone to perforation.
 - Underwood's septa management
 - Prevalence ranging from 16%-74% (mean 25-30%)
 - More commonly found in edentulous atrophic maxillae than in dentate maxillae
 - Plan with CBCT (3D)
 - Rare situation of anterior-posterior septum: need "window within a window"
 - Systemic post-operative considerations
 - Acute or chronic sinusitis
 - Pre-consult

Figure 10

Topic: Risk factors for lateral window

Authors: Testori T., Weinstein T., Taschieri S., Wallace SS

Title: Risk factors in lateral window sinus elevation surgery

Source: Periodontology 2000. 2019;81:91–123.

DOI: 10.1111/prd.12286

Reviewer: Cyrus J Mansouri

Type: Review article

Keywords: lateral window, crestal lift, risk factors

Purpose:

To review maxillary sinus anatomy and its surgical implications, assess pathologic conditions which may contraindicate sinus elevation, describe behavioral conditions impairing sinus health, diagnose and manage intraoperative and postoperative complications, draw meaningful clinical conclusions and provide recommendations for predictability.

Maxillary sinus anatomy and its surgical implications

Overview

The walls directly involved the lateral approach are the anterolateral and medial walls. The anterolateral wall may be < 1 mm thick and contain vessels, nerves, antral septa, or ridges. Dehiscences may be observed and should be avoided during flap elevation to avoid perforation of the Schneiderian membrane. Dehiscences may also be found on the roots of teeth, creating a situation where apices are protruding into the sinus cavity covered by the Schneiderian membrane only.

Crestal bone < 1.5 mm may contraindicate attempts for graft regeneration, and a residual crest of < 4 mm may be a risk factor for subsequent implant survival.

The natural ostium is found in the anterosuperior location in the medial wall and provides the drainage for the sinus. In 25% of patients, an accessory ostium is found in the mucosal area called the anterior and posterior fontanelles. It is important to not obliterate the ostium during elevator by limiting the extent the medial wall is elevated.

The Schneiderian membrane

Inner walls of the sinus are covered by the Schneiderian membrane (pseudo-stratified columnar ciliated epithelium formed by basal, columnar, and calyx cells fixed to the basal membrane).

Mean thickness of the membrane has been determined as 90 +/- 45 microns. Pathologies and subsequent inflammation may thicken the membrane. When thickening is > 4 mm on a CBCT, a referral to an ENT is indicated. Membranes may be thickened in the periosteal or subepithelial middle layer. Thickening in the periosteal layer makes the membrane less prone to perforation while thickening in the middle layer is more pathologically based and makes the membrane more prone to perforation.

CBCT appears to over-estimate thickness of the membrane by about 2.6 (30 microns measured histologically compared to 79 microns by CBCT). The membrane may be stretched to 132.6% of its original size in 1-dimensional elongation and 124.7% in 2-dimensional elongation. Thicker membranes demonstrate significantly higher stretching ability.

Maxillary sinus septa

Antral septa are a risk factor for membrane perforation during elevation and originate on the sinus floor and span up the lateral wall to variable heights. The septa divide the distal sinus in multiple compartments known as posterior recesses. Septa arise from the development of the maxilla (primary septa) or by irregular pneumatization after tooth loss leading to bone atrophy at different times in different regions of the sinus. Incidence of septa is 16-58% (average 30%). Presence of septa may indicate using 2 small sinus antrostomies anterior and posterior to the septum. Presurgical knowledge and assessment is important to adequately navigate and avoid membrane laceration.

Arterial supply

Blood is supplied by 3 main arteries: infraorbital, posterior lateral nasal, and PSA, all derived from the maxillary artery. The anterolateral wall is vascularized by the alveolar antra artery (an intraosseous anastomosis between the PSA and infraorbital artery). The location is halfway up the lateral sinus wall and is present in the cortical bone in 100% of patients (radiographically evident in 50%). The artery has been reported as 2.5-3 mm in diameter, having potential to cause bleeding complications during osteotomies. Transection of the artery is not life threatening, as hemorrhage is self-limiting due to the contraction of the vessel. Nevertheless, significant bleeding can interfere with membrane elevation and placement of graft material. Electrocautery is contraindicated as the Schneiderian membrane may be perforated in this manner. Intraosseous anastomosis between the alveolar antral artery and the infraorbital artery was also found by dissection in 100% of specimens. The canal can be located in the anterolateral wall in 47% of CBCT scans.

Other anatomic features

When elevating the medial wall, care should be taken to respect the nasolacrimal duct which may lie just a fraction of a millimeter past the medial wall.

Presurgical sinus assessment: diagnosing pathologic conditions of the maxillary sinus

It is important to identify potential diseases affecting the sinuses such as nasal obstructions, facial trauma, sinus infections, allergic symptoms, smell and taste dysfunction, pressure-related discomfort, chronic respiratory diseases, previous nasosinus surgery, facial deformities, scars, and mouth breathing. In these cases, an ENT consult is indicated prior to elective surgery. CBCT is essential for evaluating sinus anatomy, health, and patency of the ostium.

Possible sinusitis contraindications: a history of chronic and/or recurrent sinusitis (the former defined as a sinus infection lasting more than 4 weeks, and the latter as at least four episodes of acute sinusitis in the previous 12 months or at least three episodes in the previous 6 months), the chronic use of nasalsteroids and/or vasoconstrictors (not because di per se contraindicated, but because indicating a possible nasosinus disease)

Odontogenic sinusitis

An odontogenic origin of sinusitis is uncommon and may represent only 10% of sinusitis cases. However, due to the specific microbial profile of odontogenic bacteria, correct etiology is paramount for effect antibiotic prescribing. In cases of unilateral sinusitis, odontogenic pathology and dentoalveolar surgery was found to represent 64% of cases.

Behavioral conditions impairing maxillary sinus health status

Sinusitis is a common side effect of cocaine use. In the author's experience, the Schneiderian membrane is extremely thin and fragile in cocaine users, requiring even closer attention while elevating. Smoking > 15 cigarettes a day has been significantly correlated to implant failure for implants placed in grafted sinuses.

Prevention and treatment of surgical complications

Intraoperative complications

Relative frequency is quite low for the majority of complications in sinus augmentation. They are more commonly caused by complex anatomic situations, inadequate preop assessment, or operator error. The most common complication is Schneiderian membrane perforation. Other less common complications include bleeding, perforation of the buccal flap, injury to infraorbital nerve, damage to adjacent dentition, perforation of medial or orbital wall, implant displacement into the sinuses, and obstruction of the ostium.

Intraoperative bleeding

Etiology and incidence: Result from damage or severing branches of the vascular supply to the lateral wall and surrounding soft tissues. Bleeding is usually minor and of short duration. In some cases bleeding can be profuse and difficult to control.

Prevention: 3-dimensional planning is prudent to identify any arteries present in the surgical field. Location of windows can often be adjusted to avoid encountering an artery. Arteries may also be present just outside the lateral wall, in which case hand instrumentation or vertical incisions may damage the vessel. If rotary instruments are used, diamond burs are preferred to carbide burs to decrease the chance of tearing the membrane. Piezoelectric surgery may also be used to avoid cutting soft tissues of the vessel or membrane.

Treatment: Bleeding may be managed by direct pressure, localized vasoconstrictor, bone wax, use of a hemostat, electrocautery (care must be taken around Schneiderian membrane), or suturing the vessel. Best clinical practice includes preoperative identification of the vessel, visualization of the vessel clinically, avoiding the vessel with appropriate window design, use of piezoelectric surgery, having hemostatic agents readily available.

Schneiderian membrane perforation

Etiology and incidence:

Perforation is the most common complication, with an 11-56% incidence reported when rotary instruments are used. Perforation rate has been shown to be higher when Schneiderian membrane is < 1.5mm vs $\geq$ 1.5 mm (41% vs 16.6%). Presence of septa may increase perforation rate by 10%. An acute medial wall angle may also increase the rate of perforation.

Prevention:

CBCT analysis provides a multitude of the anatomy and health of the sinus as they relate to difficulty of elevation and risk of perforation and may guide the clinician for the appropriate placement of the antrostomy. Once the sinus has been accessed, good vision and instrumentation will facilitate proper elevation. Many experienced clinicians recommend the ideal location for the window as 3 mm superior to the sinus floor and 3 mm distal to the sloping anterior wall, allowing for controlled membrane elevation while keeping the elevating instruments on the bone surface at all times. When septa are present, the clinician may lengthen the window in the antero-posterior direction, so the window is located both anterior and posterior to the septum or create two separate windows. However, when making two separate windows, smaller window size will diminish access and visualization, making one longer window more advisable. Removal of the bony window may further allow the location and removal of the septum.

Piezoelectric surgical inserts or DASK (Dentium Advanced Sinus Kit) drills may be used to dramatically decrease the rate of perforation to around 5%, reported by several studies. With these instruments, the bony window may be either left in place, or removed entirely prior to instrumenting the membrane. Complete removal may decrease perforation risk by sharp protrusions of the bony window.

Treatment of membrane perforations:

An intact sinus membrane is essential for graft containment. Failure to contain the graft results in decreased bone formation (14.2% vs 33.6%) and decreased implant survival (70% vs 100%). Perforations are best circumvented by elevating the membrane around the perforation. Use of an absorbable collagen membrane is also advised to patch the membrane, especially when perforation is large. The membrane perforation may also be closed with sutures, PRF, or lamellar bone sheets. Small perforations will heal via blood clot formation. Excessively large perforations may result in loss of graft containment and may necessitate surgical re-entry for removal of graft material.

Mucous retention cysts

Mucous retention cysts have been observed in 10% of radiographic abnormalities, which were observed in 38% of cases. These cysts become problematic when the ostium is blocked after elevation. If a complication is predicted due to size of cyst, it may be handled at the time of surgery by drainage with a large-gauge needle or treated via functional endoscopic sinus surgery prior to sinus elevation surgery. ENT referral is prudent prior to surgery if they are predicted to complicate surgery. In general, a cyst which occupies two-thirds of the total sinus volume is likely to block drainage through the ostium.

Other intraoperative complications

Other complications may arise due to poor surgical technique, such as tearing of the buccal flap and injury to the infraorbital nerve. In general, release of the buccal flap is not necessary as external dimensions of the ridge should not occur, which should lead to less complications of the buccal flap. Identifying the infraorbital notch preoperatively is prudent to avoid injury.

Best surgical practice includes:

- Adequate preop analysis via CBCT
- Window placement in best location 3 mm from the floor and anterior wall
- Use of piezoelectric surgery or DASK for initial osteotomy and membrane elevation
- Elevating membrane lateral to medial, keeping elevator on bone at all times
- Repairing perforations with collagen membranes or PRF
- Use of a collagen membrane that remains rigid when wet for increased stability
- Ensure stability of repairs
- Aspirating mucous retention cysts predicated to complicate surgery

Postoperative complications

Postoperative edema, ecchymosis (bruising), mild-to-moderate discomfort, minor epistaxis (nosebleed), minor bleeding at the incision line, and mild congestion are common adverse outcomes which patients should expect following this procedure. Major postop complications are relatively uncommon, but include graft infections, sinusitis, profuse bleeding, flap dehiscence, oroantral fistula formation, inadequate graft volume formation for implant placement, loss of graft containment, and cyst formation. While serious complications are not common and usually easily remediated, improper management of some complications may lead to intraorbital or intracranial abscess formation or migration of implants into the sinuses.

Postoperative infections

Etiology and incidence of sinusitis / sinus infections

Postop infections are infrequent with reported rates 2-5.6%. It is often difficult to distinguish true sinus infection or sinus graft infection, however infection of the graft material is much more common. Infections may be avoided by sound surgical techniques and appropriate antibiotic use. True sinus infections may arise from a previously existing asymptomatic chronic sinus condition (inflammation or infection) exacerbated by postop inflammatory changes or by contamination through a membrane perforation or tear by oral bacteria or infected sinus grafting material.

When sinusitis etiology is known (periodontal, periapical, allergic), presurgical antibiotics/anti-inflammatories along with removal of etiology is indicated prior to sinus augmentation.

Etiology and incidence of sinus graft infections

Sinus graft infection is the most common form of infection following sinus elevation and occurs in approximately 2-5% of cases. Symptoms include local tenderness, nasal obstruction, pain, swelling, fistula formation, flap dehiscence, and suppuration from a fistula or incision line. Sinus graft infections may be caused by preexisting sinus infection via perforation, contamination of the surgical field, or infected simultaneous lateral ridge augmentation.

Prevention of sinus graft infections

Adequate diagnosis of potential sources of graft infection, such as periapical pathology proximal to the sinus, is prudent to minimize chances of infection. An often overlooked source of contamination is utilizing nonsterile instruments. Instruments that have been used to manipulate the mucosa of the oral cavity are considered nonsterile and not used to manipulate the mucosa of the sinus or the graft material before or during placement into the sinus. Starting a course of Augmentin (875/125 mg BID 7-10 days) a day prior to the procedure is an additional prophylactic practice to minimize chances of infection. Clindamycin has historically been used in pen-allergic patients. However, the authors with more than 28 years of experience have seen a higher rate of infections with Clindamycin use and recommend Levofloxacin or Moxifloxacin (second- and third-generation bactericidal fluoroquinolones) anecdotally as higher efficacy antibiotics.

Treatment

Symptoms normally arise within the first 2 weeks after surgery. Late infections occur less frequently. As soon as symptoms are recognized treatment of the infection should commence. Four stages of treatment may be performed sequentially as needed, until the infection resolves. Waiting time between stages should be 7-10 days.

- 1- Reinstitution and/or change of antibiotic therapy
- 2- Insertion of drain with antibiotic therapy
- 3- Partial or complete debridement of the graft material
- 4- Total debridement of the graft and sinus cavity by oral approach and/or functional endoscopic sinus surgery

Postoperative sinusitis

A decrease in low-grade sinusitis symptoms have been reported after sinus augmentation due to the sinus floor elevation creating more favorable sinus drainage. A short-term thickening of the membrane is an expected finding as a result of inflammation following the procedure. Sinusitis is reported in 3-20% of cases and is most often mild in nature, with symptoms of mild discomfort, stuffiness, and difficulty in breathing. Moderate-to-severe sinusitis is most likely due to a blockage of drainage. Etiologies of sinusitis include postsurgical inflammation, bleeding into the sinus after membrane perforation, bacterial contamination/infection after membrane perforation, blockage of the osteomeatal complex.

Prevention

All reversible preexisting sinus conditions should be addressed prior to sinus augmentation. If perforation occurs during membrane elevation, repair must ensure stability and prevention of graft migration into the sinus cavity.

Treatment

Many clinicians routinely prescribe postop decongestants such as oxymetazoline (Afrin). Others prescribe decongestants as needed. Nasal lavage with sterile saline rinses can be used as adjunctive therapy. If etiology is due to an infection and inflammation, adjunctive antibiotics and anti-inflammatories may be effective. Without resolution, a surgical debridement may be necessary, as discussed above.

Other postoperative complications

Loss of graft material through the surgical window

Increase in intrasinus pressure due to postop inflammation or bleeding within the sinus can result in graft material being lost through the window. This is likely to occur if a membrane was not properly stabilized. Displacement graft material will likely cause elevation in the buccal mucosa. An alternative way to stabilize the membrane is to place it directly inside the sinus window over the graft material, extending 2 mm in each direction past the window dimensions.

Migration of implants into the sinus or sinus graft

This complication is more common with cylindrical implants in the posterior maxilla due to inadequate or loss of primary stability. It may also be caused by loss of bone due to infection. A crestal bone height of 4-5 mm is often the minimal clinical recommendation for immediate implant placement.

Conclusion:

Sinus augmentation by a lateral window approach is a highly predictable pre-prosthetic procedure. Complications are minimal and reduced by thorough case selection, prophylactic antibiotics, good surgical technique, and proper handling of intraoperative and postoperative complications. Knowledge of sinus health and sinus anatomy is a key factor in reducing complications to a minimum.

Pre-op assessment

Topic: Pre-sinus floor elevation evaluation

Author: Torretta S , Mantovani M , Tes tori T , Cappadona M , Pignataro L .

Title: Importance of ENT assessment in stratifying candidates for sinus floor elevation: a prospective clinical study

Source: Clin Oral Implants Res 2013 ; 24 (Suppl A100): 57 - 62

DOI: 0.1111/j.1600-0501.2011.02371.x.

Type: Clinical Study

Reviewer: Veronica Xia

Keywords: sinus floor, contraindications, ENT, pre-operative assessment

Purpose:

- To describe the ENT assessment of candidates for sinus floor elevation (SFE), specifically evaluating the sinus compliance by identifying potentially reversible (PREC) or presumably irreversible (PIEC) contraindications to SFE, and the impact on SFE success

Materials and Methods:

- Patients assessed for possible general/specific risk factors for SFE and/or sin-nasal disease
- Complete ENT evaluation performed including using nasal fiberoptic endoscopy
- Additional scans were complete to view the ostio-metal-complex (OMC)
- ENT risk classified into presence of PIEC, PREC, or no ENT contraindications
 - PIEC patients were advised not to undergo procedure
 - PREC patients were prescribed appropriate treatment and followed up until complete resolution
- Anatomical alterations, scarring, polyps, and small antral cysts were not considered ENT contraindications
 - Advised surgeon evacuate cyst transantrally during SFE
- Phone interview performed 1 month after SFE to investigate post SFE symptoms in addition to assessment with a nasal fiberoptic endoscopy

Results:

- 34 patients included (45 SFE procedures)
 - Most had absence of pathological nasal conditions
 - 40% showed impaired middle meatal patency
 - 28.9% showed impaired OMC patency
 - 52.9% showed homolateral septal deviation as the main anatomical variation
 - No patients presented with PIEC
 - 38.2% of patients presented with PRECs which were resolved before SFE
 - Chronic sinusitis, endo-antral foreign bodies with/without sinusitis, and post-traumatic nose deformity
 - 8.9% experience oedema of the infundibular mucosa
 - Advised to use nasal irrigations and topical nasal steroids administered from 21 days before until 14 days after the SFE
 - Avoid SFE during allergic periods for patients with seasonal allergies, smokers advised to avoid smoking in the perioperative period, postpone SFE during acute URT infection
- No intra/post lifting complications or signs/symptoms related to post-lifting in patients with no ENT contraindications of those with PRECs

Conclusion:

- Most patients do not present any ENT contraindications to SFE
- Patients with PREC treated pharmacologically/surgically before SFE
 - Reestablish physiological maxillary drainage/ventilation and reduce risk for post-lifting maxillary sinusitis
 - Main PREC found was chronic sinusitis: 15% found as odontogenic maxillary sinusitis
 - Need to evaluate to exclude possible silent maxillary sinusitis of dental origin

- Preoperative detection of all conditions impairing maxillary ventilation and clearance is necessary to reduce risk of SFE-related morbidity □ STRESS importance of preoperative ENT assessment
- Need to use a preventive/diagnostic protocol with ENT evaluation to:
 - Detect possible PEIC/PREC to SFE
 - Treating/solving issues
 - Documenting recovery after surgical correction of PREC
 - Ensuring sinus compliance

Topic: CBCT Analysis

Authors: Shanbhag, et al.

Title: Cone-beam computed tomographic analysis of sinus membrane thickness, ostium patency, and residual ridge heights in the posterior maxilla: implications for sinus floor elevation

Source: Clinical oral Implants Research

DOI: 10.1111/clr.12168

Reviewer: Ryan Higgins

Type: Descriptive Observational Study

Keywords: CBCT, maxillary sinus, membrane thickness, sinus floor elevation

Purpose: Evaluating patients for implant placement in the posterior maxilla using CBCT to determine residual ridge height (RRH), sinus floor membrane thickness (MT), and ostium patency (OP)

Materials and Methods:

- 128 patients were included in the study with 199 sinuses examined
- Inclusion criteria included ≥ 1 missing teeth in the posterior maxilla
- MT > 2 mm was considered pathological with categorization of thickening degree (2-5mm, 5-10mm, and >10mm)
- Mucosal appearance classified as normal, flat thickening, or polypoid thickening
- OP classified as patent or obstructed

Results:

- MT >2 mm was observed in 60.6% patients and 53.6% sinuses
- Flat and polypoid mucosal thickening had a prevalence of 38.1% and 15.5%, respectively
- RRH 4 mm was observed in 46.9% and 48.9% of edentulous first and second molar sites, respectively
- Ostium obstruction was observed in 13.1% sinuses and was associated with MT of 2–5 mm (6.7%), 5–10 mm (24%), and >10 mm (35.3%, $P < 0.001$)
- Polypoid mucosal lesions were more frequently associated with ostium obstruction than flat thickenings (26.7% vs. 17.6%, $P < 0.001$)

Conclusions:

- High prevalence of thickened sinus membranes (>2 mm) and reduced residual ridge heights (≤ 4 mm)
- Increased risk of ostium obstruction when membrane thickening >5 mm, especially when polypoid type
 - ENT referral may be beneficial in presence of findings prior to implant related sinus floor elevation

Topic: Sinus lift

Authors: Janner, S et al.

Title: Sinus floor elevation or referral for further diagnosis and therapy: A comparison of maxillary sinus assessment by ENT specialists and dentists using cone beam computed tomography

Source: Clinical Oral Implant Research

DOI: 10.1111/clr.13582

Reviewer: Nicolas Lobo

Type: Comparative observational

Keywords: cone beam computed tomography, dental implants, ear, nose, and throat, maxillary sinus, sinus floor elevation

Purpose: to compare ENT specialists and dentists assessing health or pathology of maxillary sinuses using cone beam computed tomography (CBCT)

Materials and methods: The study randomly selected 100 CBCT scans of the posterior maxilla from a previous study to evaluate sinus floor elevation (SFE) eligibility and the need for ENT referral. Four blinded examiners, two ENT specialists and two oral surgeons, assessed the images, focusing on sinus anatomy and membrane thickening. The study used statistical analysis to determine inter-rater agreement, revealing higher agreement among ENT specialists. The findings informed consensus statements for patient management based on specific CBCT findings, guiding decisions on SFE and ENT referrals.

Results: All 100 datasets were successfully assessed by four raters. High agreement was found for SFE in cases without membrane thickening and for ENT referral in cases of advanced opacification. ENT specialists favored referral for irregular thickening, while dentists recommended it more often for other types. ENT specialists generally had higher agreement rates than oral surgeons. Thinner membranes correlated with higher agreement. Clinical recommendations emphasized SFE feasibility without pathology, but suggested ENT referral for significant findings like bone resorption, extensive opacification, or irregular thickening.

The agreement rate between ENT specialists (almost perfect) was generally higher than the respective rate for oral surgeons (fair).

Conclusions: The study found consensus on SFE suitability for sinuses without thickening and on referring advanced opacification cases to ENT specialists. Opinions differed on Schneiderian membrane thickening, highlighting the need for proper training and guidelines in CBCT scan assessment to prevent postoperative sinusitis.

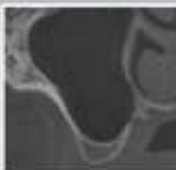
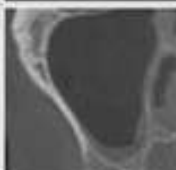
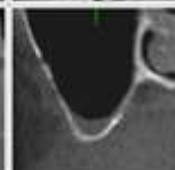
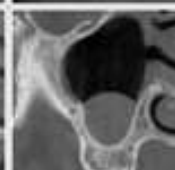
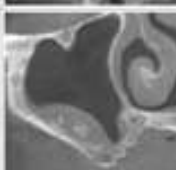
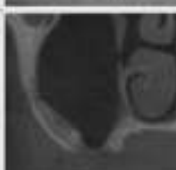
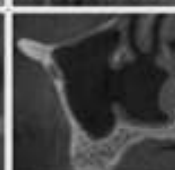
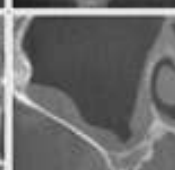
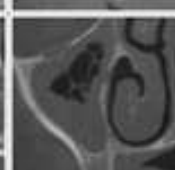
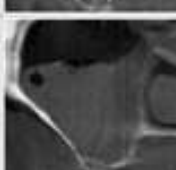
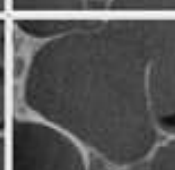
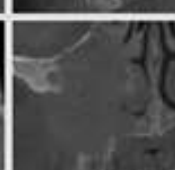
Finding	Examples		Description	Decision	Comments
			No alteration	SFE	
			Basal flat thickening		• Ostium patency prior and after SFE is mandatory • Possibly lower risk of membrane perforation
			Dome-shaped (semi-aspherical, cystic) thickening	SFE	• Fluid aspiration may facilitate SFE
			Intramural calcifications		• Decision about referral based on membrane thickening, not on calcifications • Some authors recommend referral to ENT in any case
			Iatrogenic bone defects		• SFE may be technically demanding and prone to intraoperative complications (i.e., membrane perforations)
			Circumferential flat thickening or irregular thickening		• High risk for postoperative ostium obstruction • ENT referral recommended when ostium patency not visible • Perioperative nasal decongestants are mandatory
			Air-fluid level, air bubbles		• High risk for postoperative sinusitis or graft infection • Such findings are mostly associated to symptoms of a sinusitis
			Opacification exceeds 50% of the antral volume or is mucocoele-like	ENT referral prior to SFE	• More than 50% of the antral space are non-pneumatized, regardless of the shape of the membrane thickening
			Lesion associated with destruction of adjacent structures	ENT referral, no SFE	• High likelihood for malignant lesion

FIGURE 4 Synopsis on management consensus for nine typical morphological findings in CBCT imaging of the maxillary sinus. Nine graphics are followed by two real examples each and a description of the finding, all depicted in the coronal view. The four raters reached consensus and commented on indication for ENT referral: not indicated (green), not indicated but surgical risk factors for SFE are present (yellow), indicated before any SFE and for ENT reasons (orange), or urgently indicated for potentially high-risk pathologies (red)

Topic: Maxillary sinus augmentation

Authors: Falco A, et al.

Title: A retrospective study of clinical and radiologic outcomes of 69 consecutive maxillary sinus augmentations associated with functional endoscopic sinus surgery

Source: Int J Oral Maxillofac Implants. 2015 May-Jun;30(3):633-8

DOI: 10.11607/jomi.3757

Reviewer: Mahya Sabour

Type: Retrospective study

Keywords: sinus augmentation, endoscopic surgery, implants

Purpose: evaluate the clinical and radiographic results after lateral sinus elevation with functional endoscopic sinus surgery (FESS) in patients with reversible ear-nose-throat (ENT) contraindications

Material and Methods:

- 38 patients (69 sinuses) aged 36-59 years old
- All patients received nasal endoscopy, panoramic radiograph, and a CT scan
- Selection criteria: patients with insufficient bone height (<5mm) in the posterior region with inflammatory diseases and anatomical alterations in the rhinosinusal region (eg, chronic hyperplastic sinusitis, mucocoele, ostium obstruction, anatomical alterations of the nasal septum)
- Single surgical session under general anesthesia in which the ENT performed the FESS to restore proper ventilation to the sinuses by widening the meatal ostium and removing obstructions to the drainage, and the oral surgeon performed the lateral sinus augmentation.
- Medical exam and nasal endoscopies done at 7, 14, 30 days, and 3 months after surgery
- Panoramic radiograph and CT taken at 6 months and 1 year
- Implants were placed after 6 months
- Assessed intraoperative complications, postoperative complications, clinical and radiographic resolution of the ENT disease, radiographic graft integration and implant survival rate

Results:

- 6 patients (8.7%) reported swelling of the graft site immediately post-operatively, resolved by extension of medical IV therapy for 2 days
- Sinus diseases related to ventilation were all resolved, as confirmed clinically and radiographically
- In all 69 sites, the panoramic radiograph and CT scan showed regenerated hard tissue that had homogenous radiopacity after 1 year.
 - o No radiolucencies in the graft that would indicate inflammation or poor integration
 - o No implant failures
- All periodic nasal endoscopies showed an open ostiomeatal complex without any biomaterials within the sinus
- CT at 1 year
 - o sinus membrane thickening likely since FESS does not include removal of the entire sinus mucosa but only widening of the ostium. However, this does not compromise the final result.
 - o reduced ostium patency in many cases. (increased osteum patency is strongly associated with post-op complications after sinusitis)

Conclusion: combining FESS with sinus augmentation procedures is a predictable approach in patients with sinus diseases related to a lack of ventilation, who require a sinus elevation before implant placement. This procedure allows for recovery from the rhinosinusal diseases while allowing for grafting at the same visit, reducing patient morbidity.

Topic: sinus augmentation

Authors: Niu L, Yu H, Wang J, Tang Y, Qiu L

Title: Does a Severely Resorbed Subantral Ridge Decrease Long-Term Implant Survival Rate with Sinus Floor Augmentation?

Source: Int J Oral Maxillofac Implants. 2022 Sep-Oct;37(5):905-912.

DOI: 10.11607/jomi.9453

Reviewer: Amber Kreko

Type: clinical study

Keywords: atrophic maxilla, longitudinal, residual bone height, sinus floor augmentation, survival

Purpose: To identify the impact of residual bone height on 5- year implant survival and prosthetic complication rates in patients who had maxillary sinus grafting.

Material and methods:

- 104 lateral approach maxillary sinus floor elevations in 87 patients were done with residual bone height of less than 6.5mm.
- Divided into two group: 3mm and greater (control) and less than 3mm (test).
- Treatment: Full thickness flap, bone window outlined in lateral wall of the sinus, bone was removed and sinus membrane exposed. Sinus membrane was elevate and Bio-Oss was packed. Window was covered by BioGide membrane. If residual ridge allowed primary stability, implants were placed.
- CBCTs were taken.
- Primary outcomes included implant survival rate, incidence of prosthetic complications, and grafted bone height change over time.

Results:

- 52 sinuses were included in the study group and 52 in the control.
- Preoperative residual bone height was 1.8mm in the study group and 4.1 in control.
- Surgical complications: no significant differences. 3 in study group and 2 in control had sinus membrane perforations.
- Grafted bone healing was 5.4 months in study group and 4.5 months in control group
- Grafted bone height for the study group decreased 4.3% at 6 months and 10.3% at 2 years and in the control group 2.0% at 6 months and 9.2% at 2 years.
- 5 year implant survival rate was 97.4% in study group and 100% in control. 99 implants were placed in study group and 70 in control.
- Prosthetic complication rate was 8.0% in study group and 12.5% in control. Study group complications included porcelain fracture, food impaction, dislodged crown, implant fracture and, restorative component fracture. Control group complication were porcelain fracture, food impaction, and dislodged crown.

Conclusions: Residual bone height of less than 3mm did not impact membrane perforation rate, survival rates of implants, the prosthetic complication rate, or change in grafted bone reduction after 5 years of functional loading.

Topic: Sinus wall fenestration

Authors: Testori T, Yu SH, Scaini R, Rosano G, Tavelli L, Del Fabbro M, Francetti L, Wang HL

Title: Split-Thickness Flap for the Management of a Maxillary Sinus Wall Bony Fenestration During Lateral Window Sinus Augmentation: Case Reports and Technical Surgical Notes

Source: Int J Periodontics Restorative Dent. 2022 May-Jun;42(3):311-318

DOI:10.11607/prd.5571

Reviewer: Tam Vu

Type: Case Report

Keywords: maxillary sinus augmentation, membrane, perforation, fenestration, split-thickness, split-flap

Purpose: to present a split-flap surgical technique for managing soft tissue adhesion between the sinus membrane and alveolar mucosa during lateral window sinus augmentation

Discussion:

- Survival rate of implants placed in augmented sinus via lateral window >90%
- Sinus membrane perforation most frequent complication of lateral wall sinus aug (0.4 – 41.8% prevalence)
 - Risk factors for sinus membrane perforation:
 - Membrane thickness
 - Mx sinus configuration
 - Presence of septa
 - Residual bone height
 - Antrostomy technique
 - Location and size of alveolar antral artery
- Aborting sinus aug and leaving antrostomy window open may result in adhesion of sinus membrane and buccal flap
 - Causes bony discontinuation of maxillary sinus wall
 - Can be seen on CBCT scan, need to interpret carefully when tx planning
- Healing results in fibrotic tissue in the area which makes it harder to elevate
- **Technique:** during flap elevation in surgical reentry or lateral window – carefully split tissue between alveolar mucosa and soft tissue lining sinus cavity [ensures intact tissue on both sinus membrane and buccal flap w/out perforation]

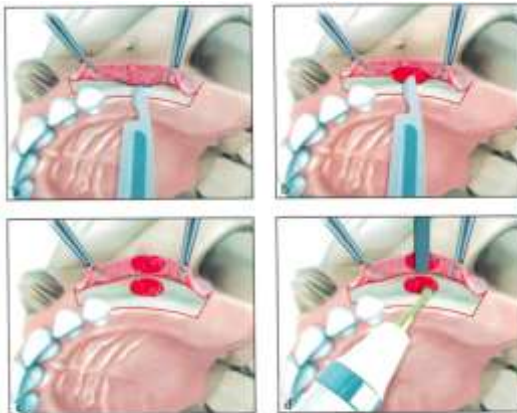


Fig 2 (a) At the level of adhesion of the two periosteal layers, a T5c blade is inserted in the submucosal layer of the buccal flap. (b) Split-thickness separation is performed until the apical part of the bony fenestration is reached. (c) Beyond the apical margin of the bone fenestration, the flap returns to full thickness. (d) A piezosonic device is then used for the initial phase of sinus elevation.

Case 1:

- Pt missing Mx right dentition >10 years

- Severe ridge resorption + sinus pneumatization results in fenestration of right Mx sinus (seen on pano + CBCT)



Fig 3 (a) A preoperative orthopantomography shows an edentulous ridge in the maxillary right quadrant. (b) CBCT cross-sectional views show a buccal bony wall fenestration.

- Surgery:
 - 15c scalpel to separate two layers of soft tissue
 - Raise split-thickness buccal flap
 - Difficult to differentiate periosteal layer of sinus membrane and overlying flap, some of buccal flap's connective tissue left on top of sinus membrane
 - Split flap more buccally while avoid perforating flap

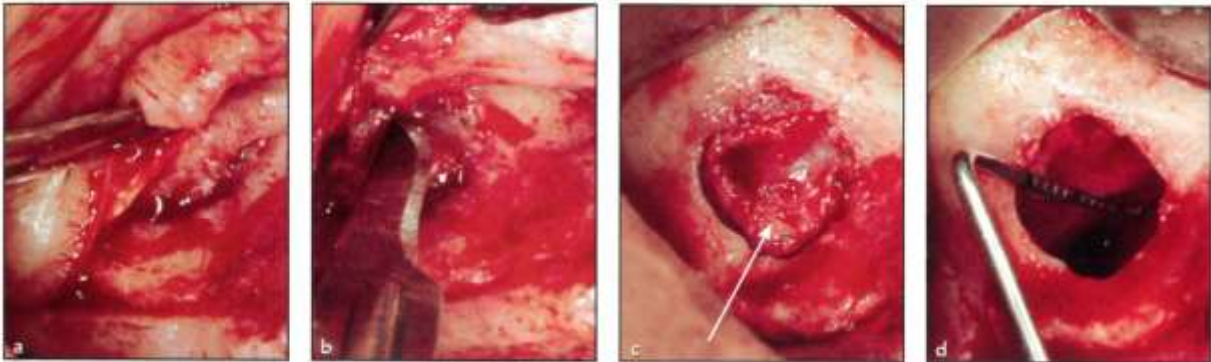


Fig 4 (a) The flap reflection stops where the two periosteal layers (the overlying flap and the sinus membrane) coalesce. (b) The blade splits the flap more buccally, paying great attention to avoid perforating it. (c) The soft tissue of the buccal flap attached to the sinus membrane is visible, only in that specific periosteal area (arrow). (d) The sinus membrane and the soft tissue of the attached buccal flap are elevated.

Case 2:

- Bone fenestration at Mx sinus floor of edentulous site
- Fenestration was at ridge level, clinician did not notice during sx, scalpel blade went inside sinus during 1st incision
- Split-flap technique applied
- Modified sinus aug with crestal access to elevate sinus membrane

Instrumentation

Topic: Lateral Sinus Lift (Instrumentation)

Authors: Atieh MA, Alsabeeha NH, Tawse-Smith A, Faggion CM Jr, Duncan WJ.

Title: Piezoelectric surgery vs rotary instruments for lateral maxillary sinus floor elevation: a systematic review and meta-analysis of intra- and postoperative complications.

Source: Int J Oral Maxillofac Implants. 2015 Nov-Dec;30(6):1262-71

DOI: 10.11607/jomi.3895.

Reviewer: Daeoo Lee

Type: Systematic/Meta

Keywords: later sinus augmentation, piezo, rotary, complications

Purpose: To compare Piezoelectric device and rotary instrument for lateral maxillary sinus floor elevation

Background:

- Rotary devices limitations
 - Lack of tactile sense for cutting depth
 - Potential bone overheating which would lead to necrosis
- Piezo advantages
 - Reduced risk of damage to soft tissue while cutting bone
 - Minimal noise and vibration
 - Precise bone cuts
 - Disadvantages: prolonged operating time (5x longer than rotary drills)

Material and methods:

- PRISMA: "Does the use of PEDs for LMSFE reduce the risk of membrane perforation, require reasonable operating time, and improve the survival rate of oral implants?"
- Randomized or non-randomize clinical trials
- Electronic database

Results:

- 124 citation retrieved but only 4 were included in the review.
- Sinus Membrane perforation
 - NSSD b/t two technique (RR = 0.87; 95% CI = 0.40-1.91; P = .73;)
- Operating time
 - SSD, favoring conventional rotary technique (mean difference 3.43 minutes)
- Implant failure rate
 - NSSD b/t two technique after 1 year of functional loading (RR = 0.20; 95% CI = 0.02-1.65; P < .14)

Conclusions:

Within the limitations of this review, PEDs and conventional rotary instruments appear equally viable surgical techniques for LMSFE before implant placement.

Within the limitations of this review, PEDs and conventional rotary instruments appear equally viable surgical techniques for LMSFE before implant placement. With the exception of prolonged operating time associated with the use of PEDs, both techniques were comparable in terms of the number of perforations and the risk of implant failure.

Comment-

Lateral window dimensions

Topic: Window dimensions and vital bone

Authors: Avila-Ortiz G., Wang HL., Galindo-Moreno P., Misch CE., Rudek I., Neiva R.

Title: Influence of Lateral Window Dimensions on Vital Bone Formation Following Maxillary Sinus Augmentation

Source: Int J Oral Maxillofac Implants 2012;27:1230-1238

DOI: Not found

Reviewer: Cyrus J Mansouri

Type: Prospective clinical study

Keywords: bone grafting, dental implants, maxillary sinus

Purpose:

To evaluate how lateral window dimensions influence outcomes of bone grafting following sinus augmentation.

Material and methods:

Patients in need of sinus augmentation via a lateral approach prior to implant therapy were recruited for this study at UMichigan School of Dentistry. Remaining bone height in all subjects was ≤ 6 mm (assessed by periapical radiograph). Lateral windows were prepared by a rotary diamond bur technique and window dimensions were approximated in mm^2 at the time of surgical procedure using a UNC15 probe to the nearing 0.5 mm. Cortico-cancellous allograft particles were used as the grafting material (MinerOss 500-1250 μm). Lateral cortical bone was left attached to the sinus membrane. Collatape was draped over the window site prior to closure with primary intention. Patients were followed for 6 months, at which point bone core biopsies were harvested during implant placement. Biopsies were analyzed by histomorphometry, where vital bone, remaining allograft particles, and nonmineralized tissue were quantified by %.

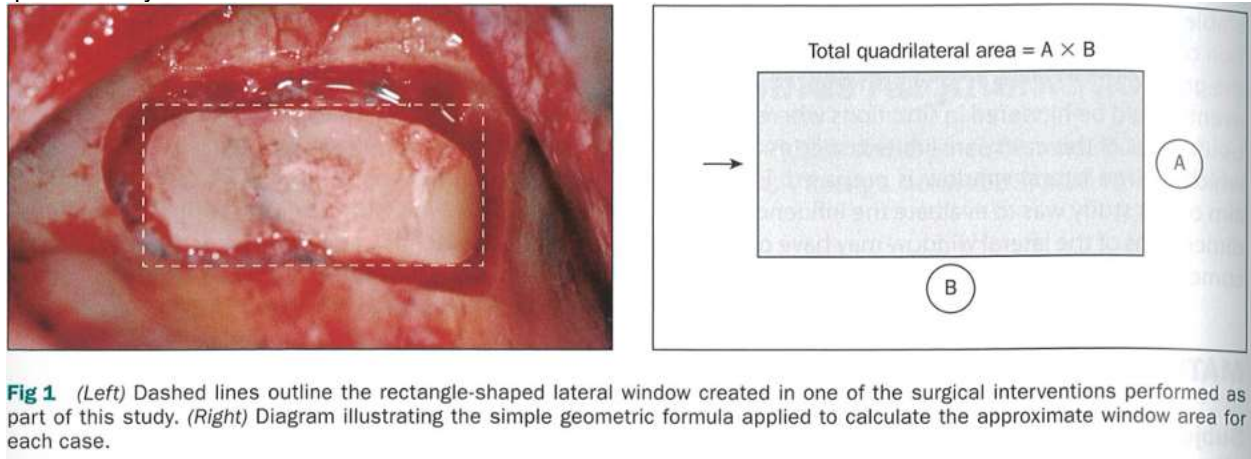


Fig 1 (Left) Dashed lines outline the rectangle-shaped lateral window created in one of the surgical interventions performed as part of this study. (Right) Diagram illustrating the simple geometric formula applied to calculate the approximate window area for each case.

Results:

A total of 24 sinus augmentations were completed in 21 patients. Total volume of allograft material ranged 3-5 cc and average window was 69.71 mm^2 (± 26.24). Membrane perforation incidence was 21.73% of sinuses with a max diameter of 3 mm and were sealed intraoperatively. One sinus infection was encountered and excluded.

Histomorphometry revealed mean values of:

- 21.69% vital bone ($\pm 16.30\%$)
- 23.51% residual allograft particles ($\pm 16.33\%$)
- 55.08% nonmineralized tissue ($\pm 8.52\%$)

A strong negative correlation was found between window dimension and % vital bone (smaller window = more vital bone). A strong positive correlation between window dimension and % residual allograft

particles (larger window = more residual particles). A small positive correlation was found between window dimension and % nonmineralized tissue (relationship not statistically significant).

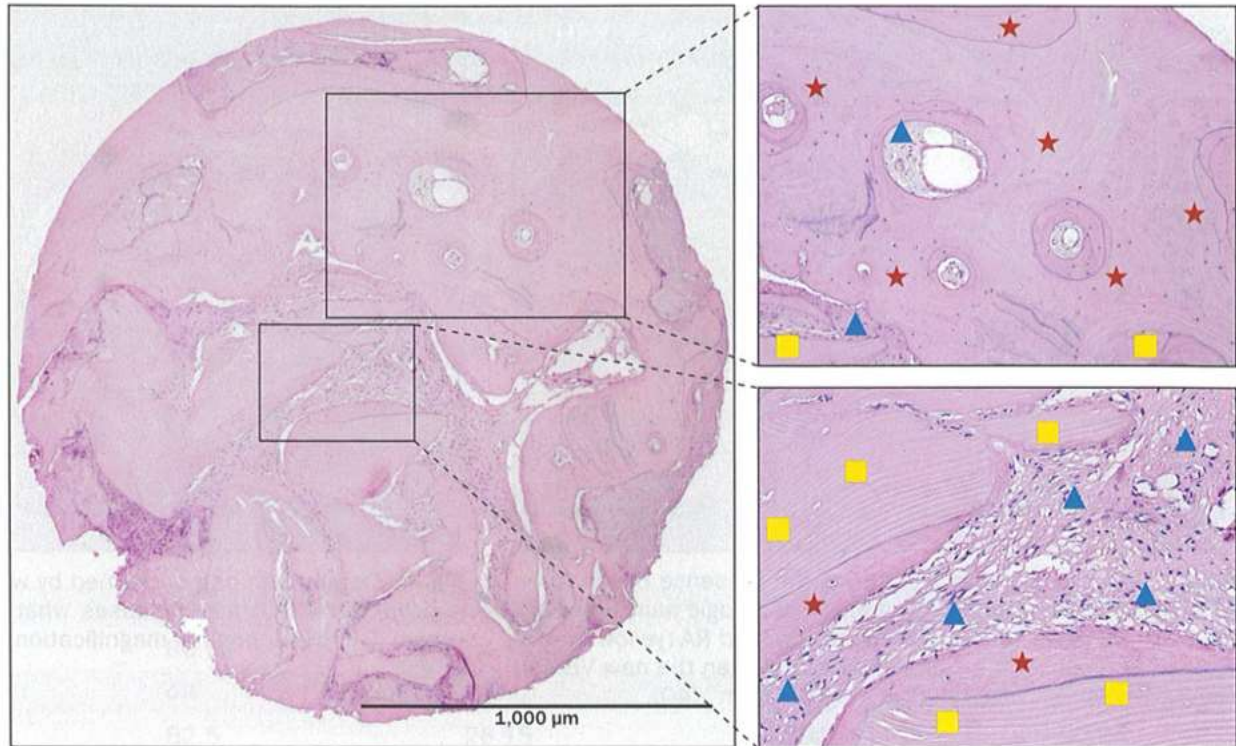


Fig 2 (Left) Histologic section of one of the samples obtained after transversal section of a bone core biopsy (H&E, original magnification $\times 2$). Two images (right) at a higher magnification showing details of the same sample. (Top right) Note the predominant presence of VB (red stars) in intimate contact with RA (yellow squares) and a minimal proportion of NMT (blue triangles) (H&E, original magnification $\times 10$). (Bottom right) Newly formed VB over RA particles embedded in an NMT matrix (H&E, original magnification $\times 20$).

Conclusion:

Window dimension may have an important influence on the maturation and consolidation of bone grafting during sinus augmentation. Smaller windows may allow for increased angiogenesis and migration of osteogenic and osteoclastic cells from the local host bone, critical for healing of human bone.

Topic: Low Window Sinus Augmentation

Author: Zaniol T, Zaniol A, Ravazzolo S, Testori T, Wallace SS.

Title: Low Window Sinus Elevation Technique: Bone Gain and Postsurgical Discomfort. A Retrospective Case Series.

Source: Int J Periodontics Restorative Dent. 2022 Jul-Aug;42(4):449-457.

DOI:

Type: Case Series

Reviewer: Veronica Xia

Keywords: sinus augmentation, bone gain, low window approach, guided template, post-surgical findings

Background:

- Low Window sinus elevation technique:
 - Positioning window as low/mesially as possible with aid of digitally designed surgical template
 - May reduce risk of sinus membrane perforation
 - No releasing incisions and less invasive than other lateral preparations

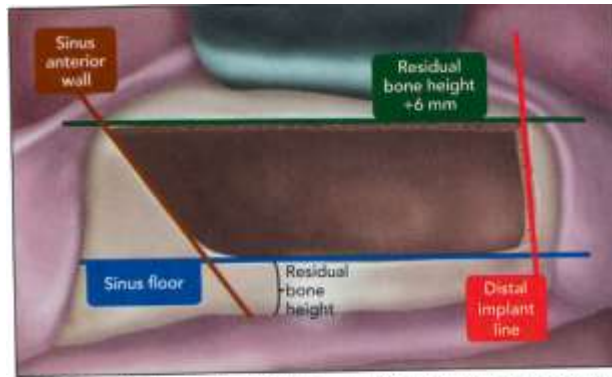


Fig 1 The Low Window sinus elevation antrostomy. The lower osteotomy line (blue) is flush with the sinus floor. The upper osteotomy line (green) is 6 mm higher—ie, at a distance from the ridge equal to the residual bone height plus 6 mm. The mesial line (brown) is flush with the sinus anterior wall. The distal line (red) should correspond to the position of the most distal implant. This design involves elevating a mucoperiosteal flap without vertical incisions, allows easier detachment of the sinus membrane, and reduces the risk of membrane perforation and damage to the intracranial anastomosis between the infraorbital and superior alveolar arteries.

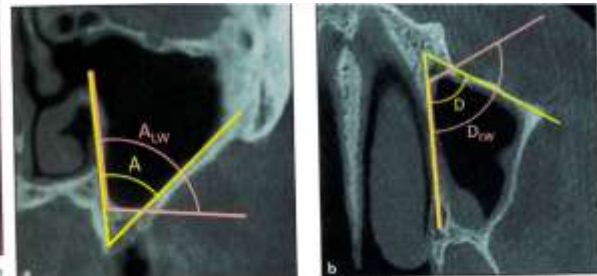


Fig 2 (a) Because the lower osteotomy line is always flush with the sinus floor in the Low Window antrostomy design, the surgical angle when approaching the sinus membrane to detach it (A_{low}) will always be independent from the anatomic angle (A). Even if the A angle was < 30 degrees, the A_{low} angle would still be > 90 degrees. (b) Similarly, when looking at the coronal plane, the mesial osteotomy line is always placed flush with the anterior sinus wall, and the surgical angle D_{low} will always be greater than the D angle. This facilitates sinus membrane elevation.

Purpose:

- Quantify immediate bone gain/pain, hematomas, and swelling of patients who underwent the Low Window technique, with further investigation of findings associated with osteotomy size

Materials and Methods:

- Included patients with maxillary atrophy and partial/total maxillary edentulism
- CBCT exam performed to plan implant positions and make surgical guide (including guide for Low Window technique)
- Surgical procedure
 - FTF with no vertical releasing incisions, guide positioned, piezoelectric tips with sterile saline irrigation used to create window
 - Sinus membrane elevated and resorbable membrane placed
 - Placed corticocancellous 0.5-1mm or 1-2mm into cavity and covered with resorbable membrane
 - In one stage surgery, implants were placed in positions according to guide because cavity full
 - Suspended internal-external sutures with 4-0 resorbable and flaps sutured with 5-0 nonresorbable
 - Suture removal after 7-10 days with monthly recall
 - Two stage surgery patients had implants placed 4-6 months after sinus grafting
 - 4-6 months after implant placement, implants uncovered and healing abutments placed
 - Follow up at 3 weeks and impressions made, provisional after 10 days, definitive prosthesis 3 months later

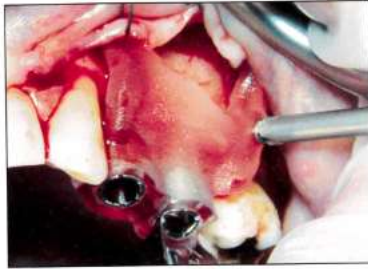


Fig 5 The Low Window surgical guide is positioned.

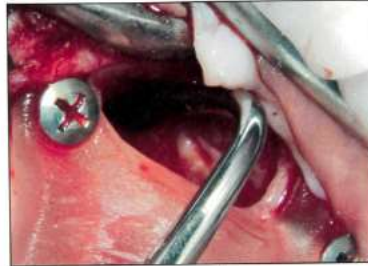


Fig 6 The sinus membrane is elevated.



Fig 7 A collagen membrane is placed under the sinus membrane to protect it.



Fig 8 The sinus is grafted with heterologous bone graft.

Results:

- 34 sinus lifts with 97 implants placed
 - No case of sinus membrane tearing/other intrasurgical complication
 - 1 implant failed to osteointegrate and was removed
 - VAS pain, swelling scores, and hematoma frequency were NSSD between one-stage vs two-stage
 - All decreased significantly from day 2 post surgery
 - Swelling prevalence (none after day 4)
 - Day 1: 29.4%
 - Day 2: 20.6%
 - Day 3: 2.9%
 - Prevalence of hematomas (none after day 4)
 - Day 1/2: 8.8%
 - Day 3: 2/9%
 - Average bone window area: 100.1 +/- 12.4 mm²
 - VAS post surgery correlated significantly with window area
 - No correlation to bone gain
 - 10.1mm medial gain, 11.6 middle gain, 10.7mm lateral gain

Conclusion:

- Low Window technique is safe and can achieve a 5-year implant success rate of 99% with marginal bone gain similar to other sinus augmentations
 - Less clinical trauma (no vertical incisions) □ associated with increased postop swelling)
- Pain, swelling, and presence of hematomas decreased significantly by day 2 post surgery

Mucous retention cysts

Topic: Mucous Retention Cyst

Authors: Yu, et al.

Title: Histological and clinical outcomes of lateral sinus floor elevation with simultaneous removal of a maxillary sinus pseudocyst

Source: Clinical Implant Dentistry and Related Research

DOI: 10.1111/cid.12708

Reviewer: Ryan Higgins

Type: Clinical study

Keywords: antral pseudocyst, bone regeneration, sinus floor elevation

Purpose: Investigate a modified technique for the removal of maxillary pseudocyst with simultaneous sinus floor elevation, and evaluate outcomes of bone grafting via clinical and histological methods

Materials and Methods:

- Inclusion criteria for patients included a radiographic done-shaped opacity in the posterior maxillary sinus, residual alveolar ridge height <5 mm, buccolingual bone width >6.5 mm, and absence of bony septa in the area of augmented sinus
- Procedure of lateral sinus floor elevation with simultaneous pseudocyst removal completed
 - o Pseudocyst removed via intentional perforation of sinus membrane, aspiration of fluid with fine needle, and removal of lesion with tissue pliers
 - o Grafting completed using large-particle Bio-Oss
- Bone core specimens harvested from site were histomorphometrically analyzed 6 months after surgery
- Data evaluated in terms of survival rates and complications

Results:

- 15 patients were included, resulting in 17 maxillary sinus augmentation surgeries
- Implant survival rate = 97%
- 17 Bone biopsy specimens were obtained, mean percentages recorded:
 - o Mineralized bone = 24.9% $\pm$ 18.1%,
 - o Bone substitute = 14.4% $\pm$ 12.5%
 - o Nonmineralized tissue = 60.1% $\pm$ 12.44%
- No recurrence of pseudocyst was detected via radiographic examination

Conclusions:

- Results show the described technique can be applied to clinical practice to perform sinus augmentation immediately after removal of pseudocysts
- Detailed clinical and radiographic evaluation must be completed prior