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Maxillary Sinus Floor Elevation Techniques

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Review Article

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ABSTRACT

With the increased popularity of dental implant therapy for the replacement of missing teeth, a need arose for a method to provide patients with bony support for these implants in cases where alveolar ridges volume were insufficient for implant placement. The posterior region of the maxillary alveolar ridge is an ideal example with severe atrophy of ridge due to faster resorption and pneumatisation of the maxillary sinus. This often required sinus floor elevation and grafting. The techniques of sinus floor elevation started early in the 1970s as direct sinus lift to indirect sinus lift with osteotomes in the 1990s and recently computer-guided templates being used for this purpose. This article enumerates various techniques available for sinus floor elevation and their complications and management.

Keywords: Sinus, Floor, Maxillary, Elevation Techniques.

Introduction

In the modern dentistry rehabilitation of partially or edentulous patients with implant-supported prosthesis has proven to be a great success with reliable long-term results. Implant prosthesis often provides increased longevity, improved function, bone preservation, and better psychological results when compared with traditional methods of tooth replacement.[1] the ideal condition for the successful installation of dental implants is when the implant possesses a minimum of 1.5 mm of bone tissue along its entire circumference.[2] However, severely atrophied edentulous alveolar ridges that are thin, sharp, and shallow renders the rehabilitation with dental implants a challenging and cumbersome task.[3] The posterior maxilla is an ideal example of this which frequently comes with significant anatomic limitations like inadequate vertical dimension, poor bone quality,

thin or missing cortex and undercuts which is more or less attributed to osteoclastic activity and pneumatisation of maxillary sinus.[4] Many reports have concluded that a minimum implant length of 10 mm, with a diameter of between 3 and 4 mm, is necessary to guarantee the long-term success of implants, particularly in the maxilla, where the bone quality is generally poorer than in the mandible. This often required sinus floor elevation and augmentation with grafting.[5] The purpose of this paper is to describe the evolution of the sinus floor elevation techniques and enumerate all the techniques from when the concept of sinus lift was first reported to the present augmentation procedures in practice.

Anatomy

Augmentation of sinus floor or sinus graft surgeries require in-depth knowledge of the anatomy of the maxillary sinus. The Antrum of Highmore is the largest of all the paranasal sinuses draining into the middle meatus of the nose. It was first were first illustrated and described by Leonardo da Vinci in 1489 and later documented by Nathaniel Highmore in 1651.[6] The size of the sinus varies in every human body but the average width of adult maxillary sinus vary from 25 to 35 mm, height ranges from 36 to 45 mm and length ranges from 38 to 45 mm containing a volume of nearly 12-15 ml of air.[7] the shape of the sinus is pyramidal in a structure whose apex points towards the zygomatic process of the maxillary bone and base lies close to the nasal cavity.[8] Anterior wall of the sinus extends from the inferior orbital rim to the alveolar process of maxilla which serves as the site for the lateral antrostomy i.e Caldwell-Luc approach for sinus surgery. The posterior wall is the separation between the maxillary sinus and the infratemporal fossa. The superior wall forms the floor of the orbit while the medial wall is close to the nasal cavity serving as the lateral nasal wall of the cavity.[9] Primary ostium which also serves as a primary channel for drainage of secretions also lies in the superior aspect of the medial wall, the opening of the ostium or **semilunar hiatus** is 18-35 mm(mean 25.6 mm) from the nasal floor, this fact prevents the blockage of sinus during augmentation.[10] The floor of the sinus is 1cm below the nasal floor and extends from cuspid or bicuspids anteriorly to the maxillary tuberosity area posteriorly with its lowest part lying near the first molar.[11] The whole inner compartment of the sinus is lined by pseudostratified ciliated epithelium with a thickness of 0.8- 1.0 mm which is called **the Schneiderian membrane** and it is continuous with the nasal mucosa and they connect at the ostium.[12] Maxillary sinus septa are cortical bone projections that were first mentioned by Underwood in 1910. These are mentioned to be present in 25% to 31.7% of cases with length ranges from 2.5 to12.7 mm.[13]

The bony walls and thin mucous membrane of the sinus gets its blood supply from the posterior superior alveolar artery, inferior orbital artery, greater palatine artery, and sphenopalatine artery. Innervation of the maxillary sinus is supplied by the branches of the second division of the trigeminal nerve through the infraorbital, superior alveolar and palatine nerves.[14]

History

The technique of maxillary sinus lift was first introduced by Tatum in the 1970s and developed a modified Caldwell-Luc procedure to lift the membrane via a lateral approach published later on in 1980 by Boyne and James.[15] Later on, in 1994 Summers introduced a less invasive technique for sinus floor elevation with dental implant placement which is also referred to as 'Osteotome/crestal sinus membrane elevation.'[16] A classification based on a treatment option approach to the maxillary posterior edentulous region was presented by Misch and Judy in 1987, dependent on the available bone height between the floor of the antrum and the crest of the residual ridge in the region of the ideal implant locations.[17]

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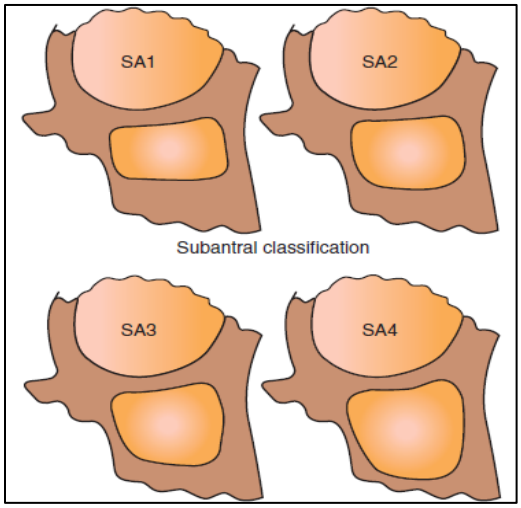
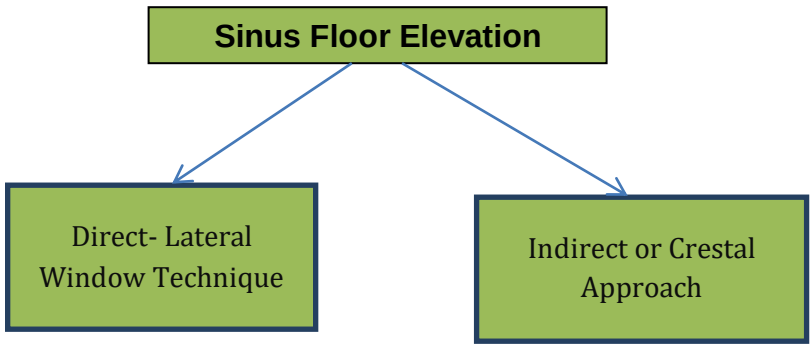


SA1: It has sufficient available bone height for implants placement, which is 12 mm. No manipulation of the sinus is required.
SA2: It has 0-2 mm less than the ideal height of bone (10 -12 mm and may require surgical correction.
SA3: It has just 5-10 mm of bone height with sufficient width (around 6mm) below the sinus.
SA4: It has less than 5 mm of crestal bone height and width below sinus.[17]

Figure.1 Maxillary Sinus Classified on the Basis of Residual Bone Height[17]

Different Techniques of Sinus Floor Elevation (SFE)

The technique for sinus floor elevation usually depends upon the surgeon's preference and anatomy of the patient such as residual bone height, the thickness of the membrane, and the amount of lift desired. There are two major techniques of augmentation of the sinus floor for dental implant placement:



Direct/Lateral Window Technique

The lateral window sinus elevation is a widely used augmentation procedure that enables placement of an appropriate length implant in the posterior part of the maxilla where the bone quality is often poor. The sinus membrane is directly visualised through the window in the lateral wall of the maxillary sinus in this technique.[18] Steps in the direct/lateral window technique of maxillary sinus floor elevation are as follows:

1. **Anaesthesisa:** Local anesthesia with epinephrine (articaine, lidocaine) is usually administrated-posterior superior nerve block, infraorbital nerve block palatal infiltration, or a greater palatine nerve block can be given.
2. **Incision:** The initial incision is midcrestal extending well beyond the planned extension of the osteotomy. The incision line should not cross the planned area of the lateral window. In the case of the presence of neighbouring teeth, the incision starts from the mesial area of the anterior tooth and extends until the distal portion of the posterior tooth.[19] Mesial and distal releasing incisions are made avoiding the infraorbital plexus below the infraorbital foramen.[20]

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3. **Flap Elevation:** A mucoperiosteal full-thickness flap is raised slightly superior to the anticipated height of the lateral window (antral wall). The flap reflection should reach the zygoma buttress to visualize the lateral side of the maxilla. The reflection should be extended beyond the borders of the future osteotomy (window).[21]
4. **Window Preparation:** The window outline is prepared in the lateral aspect of the buccal alveolus. The size of the window is determined by the area to be grafted in the lateral aspect of the buccal alveolus. The osteotomy (window) can be oval or rectangular. A high-speed handpiece can be used depending upon the quality and thickness of the buccal wall with copious saline irrigation is utilized to outline the complete extension of the osteotomy (window).[22] Lateral SFE approach today involve numerous antrostomy designs: three different methods are described here for handling the buccal cortical bone plate to introduce the selected bone substitutes.[21]

A. Top-Hinge or Trap Door Techniques

i. This technique is similar to the Caldwell-Luc approach creating an infracture of the cortical bony plate like a trapdoor. This is then used as the superior border of the sinus compartment leaving it attached to the underlying Schneiderian membrane.[23]

ii. The first to be done is the inferior horizontal segment of the rectangle, which is made as close as possible to the floor of the sinus and around 2–3 mm above the floor. The superior horizontal segment of the rectangle is performed by drilling closely positioned holes. This creates a trapdoor, which will be fractured inward and displaced medially while hinging on its superior margin (along the superior aspect of the rectangle).

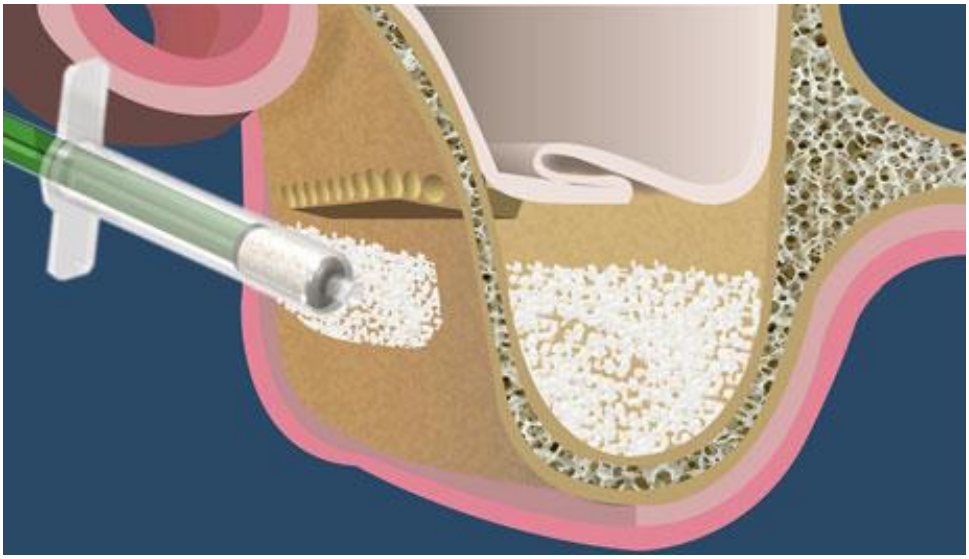

Figure.2 Top-Hinge or Trap Door Technique of SFE[25]

B. Repositioned Bony Window

In this technique, following the preparation of a rectangular osteotomy using lateral window is gently mobilized.

I. A small periosteal elevator or a Freer elevator is carefully inserted into the osteotomy line and the bony window is easily detached from the underlying sinus membrane and stored in saline.

II. The sinus membrane is dissected around the margins of the window and extended inferiorly to expose the floor of the sinus in the edentulous area. The bony plate will then be repositioned in place on the lateral aspect of the graft material without rigid fixation.

III. It not only stabilizes the graft material but also promotes early healing.[24]

C. Complete Osteotomy

I. The third and most common surgical technique is the preparation of an access hole by removing the entire buccal bone plate (thinning of the buccal bone to a paper-thin bone lamella before the elevation of the sinus membrane).

II. The preparation is continued until a bluish hue of the sinus membrane is observed. The osteotomy border should be as smooth as possible, avoiding cutting edge to reduce the risk of membrane tearing.[25]

5. Lifting the Schniederian Membrane

Usually, membrane elevation starts at the edges, using a short curette, increasing gradually the amount of membrane elevation from the superior border of the osteotomy, proceeding approximately 2–3 mm mesially, toward the mesio-superior line angle and along the mesial part of the window. Surgical curettes should be permanently in tight contact with the underlying bony walls to minimize membrane tearing. Moreover, the membrane must be elevated higher than the superior osteotomy to prevent excessive pressure on the bone-graft material.[26]

6. Introduction of the Grafting Material into the Sinus

It is possible to place implants immediately if there is a good quality of 3-4 mm of crestal bone available else implant should be placed after 4-6 months of grafting.[25]

The grafting material should be pushed through the window in all directions: mesially and distally with the help of instruments such as pluggers, periosteal elevators, or even osteotomes. Most importantly, it must reach the medial wall of the maxillary sinus. It should be placed in the cavity loosely, avoiding overpacking. Sinus augmentation with platelet-rich-fibrin as a sole grafting material has also shown promising results with simultaneous implant placement.

7. Berrier Membrane Placement

The membrane barrier is used to cover the osteotomy site extending 2–3 mm beyond its borders, promoting hemostasis, and preventing graft disruption at the time of suturing. Collagen membrane does not require fixation screw as it adheres to the bone and resorbs by itself.[27]

8. Suturing Technique

Single interrupted sutures (non-resorbable monofilament 5/0 or 4/0 sutures) are mainly used for the releasing Incisions. Uninterrupted or mattress sutures are used specifically on the top of the ridge in case of delayed or submerged implant placement.[28] Sutures should be removed 10 days to 2 weeks following the SFE procedure.

Advanced Techniques of Lateral Window Technique for Sinus Floor Elevation (SFE)

1. Piezoelectric Surgery in Sinus Lift Procedures

Piezosurgery, a surgical technique invented by Dr. Tomaso Vercellotti, and first published in the United States in 2001, uses low-frequency ultrasonic vibration to create the lateral window and elevate the sinus membrane. Piezosurgery can be particularly useful for the preparation of the bony window (diamond-coated square or bell-shaped tips) and in atraumatic dissection of the thin and delicate sinus membrane with specially designed tips (rounded, dull, bell-shaped, or curette-shaped tips).

Figure.3 Piezoelectric Kit Including Various Tips[29]

The advantages of SFE using piezoelectric techniques are:

I. Reduced membrane perforation rate.
II. Improved intraoperative visibility.
III. Reduced intraoperative bleeding.
IV. Reduced surgical trauma.[29]

2. One-Stage Sinus Floor Elevation with Simultaneous Implant Placement

- A relatively small buccal window is created in the lateral wall of the maxillary sinus to preserve the residual bone for better implant osseointegration.
- Implant site preparation is performed according to soft bone protocol i.e. undersizing for better primary stability. Condensed bone is achieved by using only the small diameter pilot drill (2 mm generally), followed by the application of osteotomes or the implant itself, thus condensing the bone in a lateral direction to enhance primary stability.
- Graft material placement in the created cavity should be initiated before inserting the implant and meticulous condensation did toward the medial bony wall of the cavity.
- Implants are then placed in their final position and graft condensation is completed after implant stabilization. Achieving primary stability relies on both bone quality and quantity.[30]

3. Computer Guided Sinus Floor Elevation

Computer-guided antral wall elevation was first introduced by Manderales and Rosenfeld in 2008.[31]

- The digitally printed surgical guide is adapted tightly to the maxilla and fixated in place using titanium mini-screws and verified for stability.
- After accurate fixation, a round diamond bur is used to create the outlines of the osteotomy following the contours of the surgical guide. The surgical guide is then removed and the sinus membrane is carefully elevated along the lateral, inferior, and medial walls.
- The surgical stent is reinserted and fixed in its place again and pilot drills are used to initiate implants drilling. The stent is finally removed and drilling of the implants osteotomies is completed.
- No graft material is used to augment the created volume. A collagen membrane (Hypersorb) is used to cover the bony window and wound closure is achieved using 4-0 vicryl sutures.[32]

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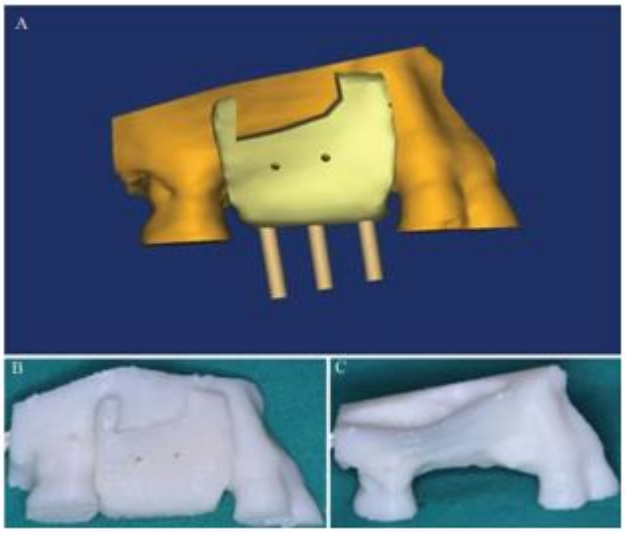

Figure.4 Digitally Printed Surgical Guide[32]

Indirect/Crestal Sinus Floor Elevation Technique

Osteotome-mediated transcrestal SFE approach was first proposed by Tatum in the 1970s. In his original publication in 1986, a special instrument known as "socket former" (for a selected implant size) was used to prepare the implant site leading to a controlled "greenstick fracture" of the sinus floor, moving it in a more apical direction. Root-formed implants were then placed and allowed to heal in a submerged manner.[33]

In Brief, the Summers Technique is Performed in the Following Way:

1. A Midcrestal incision where buccal and palatal mucoperiostal flaps are reflected in a full-thickness approach exposing the crestal part of the alveolar ridge.
2. The implant sites are marked with a 2.0 mm round drill and then prepared with a drill to a depth of 0.5–1.5 mm from the sinus floor.
3. The Concave tipped tapered osteotomes with increasing diameters are then selected to expand the preparation area both horizontally and vertically. The osteotome itself should never penetrate the maxillary sinus. With each insertion of a larger osteotome, bone is compressed, pushed laterally and apically. A mallet is used, when needed, on the osteotome to expand the bone.
4. The sinus elevation is delayed until the osteotome with the final apical diameter is used at the desired working depth. Once the largest osteotome has expanded the implant site Graft is inserted in the osteotomy site, before the in-fracture of the sinus floor.
5. The sinus floor fracture is obtained with the final osteotome, punching out the cortical plate of the sinus floor with the adherent sinus membrane. A different pitch of tapping sound can be a sign that a portion of the sinus floor has been fractured upward and inward into the sinus cavity. A bone graft can be added and tapped to achieve the desired amount of sinus membrane elevation.[34,35]

This intrusion procedure produces a fracture in the least traumatic way possible. Furthermore, it allows more implants to be inserted in a greater variety of sites during a routine office procedure.[36]

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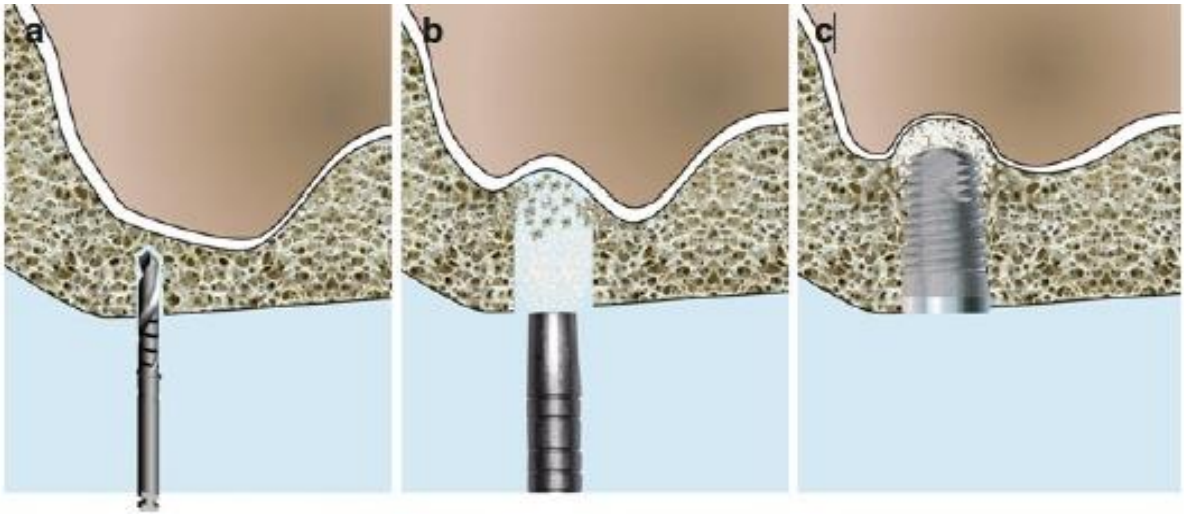

Figure.5 Schematic Drawings Illustrating the Modified Osteotome Technique[26]

Advancemets in Crestal Sinus Lift Procedure

1. Modified Trephine/Osteotome Approach (Simultaneous Implant Placement)

Fugazzotto (2002) presented a technique in which a trephine with a 3.0 mm external diameter is utilized instead of a drill (or an osteotome) as a first step, followed by an osteotome to implode a core of residual alveolar bone before simultaneous implant placement.

- This technique could be utilized either following a flap reflection or using a flapless approach.
- A calibrated trephine bur with a 3.0 mm external diameter is used to prepare the site within approximately 1–2 mm of the sinus membrane at reduced cutting speed.
- Following removal of the trephine bur, a calibrated osteotome corresponding to the diameter of the trephine preparation is used under gentle malleting forces, to implode the trephine bone core to a depth approximately 1 mm less than that of the prepared site.
- The widest osteotome utilized will be one drill size narrower than the normal implant site preparation.
- Implant placement induces a lateral dispersion of the imploded alveolar core with gentle and controlled displacement.

This technique lessens the patient's trauma and preserves a maximum amount of alveolar bone at the precise site of anticipated implant placement.[37]

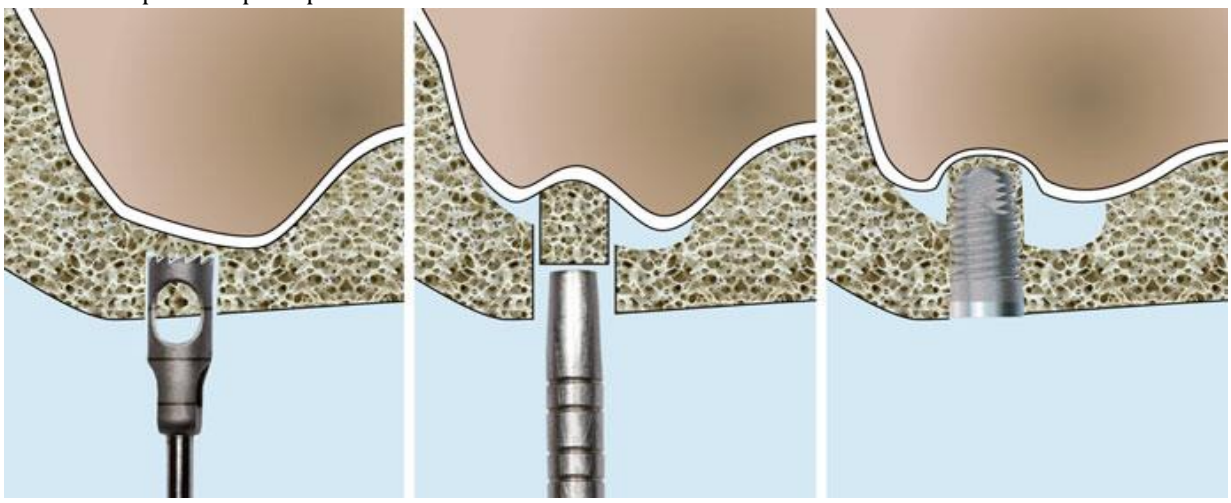

Figure.6 Schematic Drawings of Modified Trephine/Osteotome Approach.[26]

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2. Cosci Technique

The crestal approach technique has been also modified by Cosci and Luccioli (2000). Cosci technique is a one-stage crestal SFE approach using a specific sequence of atraumatic drills of varying lengths.

The shape of the drill tip prevents perforation of the sinus membrane and permits gentle abrasive removal of the cortical bone of the sinus floor without fracture. Description of Cosci technique.

- **If the RBH is 6–7 mm:**
  - A dedicated trephine drill of a 3 mm diameter is initially used for the starting 2–4 mm of the depth of osteotomy site.
  - The dedicated 3 mm long and 2 mm diameter pilot drill is then used.
  - Followed by the 3 mm long intermediate and 3.1 mm diameter drill and by one or more atraumatic lifting drills for the actual height of the ridge as measured on the radiograph.
- If the residual bone height is 4–5 mm: the trephine drill is not used, and the site is initially prepared with the dedicated 3 mm long and 2 mm diameter pilot drill, the rest of the preparation procedure being identical.

After using the first atraumatic lifting drill, the site is probed with a blunt instrument to feel the presence of the Schneiderian membrane. If the presence of bone is felt, a 1 mm longer atraumatic lifting drill is used, and so on, until the sinus lining is felt. Then, the graft is gently pushed into the site using a particular instrument called "body lifting"; this step is repeated until the site is filled with the graft. According to the Cosci technique, eight atraumatic SFE drills are available in the kit with incremental lengths of 1 mm starting from 5 mm to12 mm.[38,39]

Figure.7 Dr. Cosci's Non Invasive Sinus Lift Kit[39]

3. Balloon Sinus Lift Technique

The sinus lift balloon was created to reduce the chance of sinus membrane perforation originally described by Soltan and Smiler(2005). The inflated sinus balloon was designed to lift the Schneiderian membrane gently and uniformly. The balloon instrument can also be used to anticipate the required bone graft material, such as 1 cc of saline, which is used to inflate the balloon, equal to 1 cc of grafting material. On average, with 1 cc of saline, the sinus lift balloon may elevate the sinus membrane by 6 mm.

There are three types of design:

- Angled design can be used in the lateral window/Caldwell-Luc approach.
- Straight design can be used in the crestal / Summer's approach.

- Micro-mini design can be also used in the crestal / Summer's approach with a small diameter opening (1.9 mm).

Clinical Procedure

1. The initial osteotomy (a pilot drill of 2 mm in diameter) after a flap or flapless procedure is performed to a depth 1–2 mm short of the floor. A small diameter osteotome can be used to penetrate the sinus floor.
2. It is recommended to inflate and deflate the balloon extraorally several times with normal saline before inserting it into the sinus cavity.
3. Once the balloon is inserted into the sinus cavity, the balloon can be pumped with normal saline.
4. A bone graft can then be inserted through the osteotomy site. The dome-shaped bone grafting material can be seen via radiograph.
5. A dental implant may be placed during the same procedure.[40]

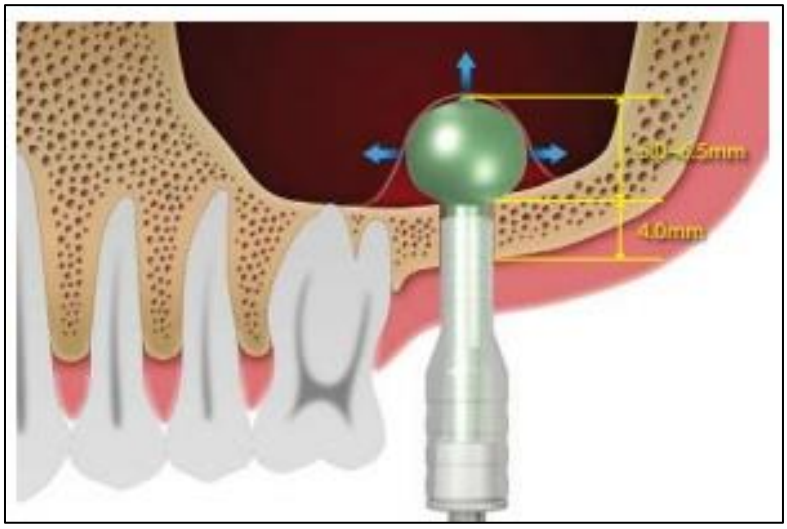

Figure.8 Sinus Floor Elevation Using Baloon Technique[41]

4. Hydraulic Sinus Lift Procedure

Besides balloon sinus lift, other surgical techniques have been proposed to minimize the tapping motion by using hydraulic pressure, the so-called "hydraulic sinus lift" procedure.[42] The unregulated hydraulic pressure is applied into the osteotomy site by means of air/water exhaust spray from a high-speed dental handpiece or an uncontrolled water jet from a plastic syringe, to detach the Schneiderian membrane from the sinus floor. The applied hydraulic pressure is designed to loosen the membrane.[43] In order to provide suitable equal distribution of hydrostatic pressure, the concept of "controlled hydrostatic sinus elevation" was introduced. This controlled hydrostatic sinus lift procedure is accomplished by using a calibrated, hand-controlled pump and pressure sensor meter.[42]

5. Minimally Invasive Transcrestal (MITSA) Approach Using CPS Putty to Elevate the Sinus Membrane

This technique was documented by Kher*et al.* 2014 by using calcium phosphosilicate (CPS) putty for hydraulic sinus membrane elevation as a modification of Summers' technique. A small quantity of approximately 0.2 cm of CPS putty is delivered in the osteotomy via a narrow tipped cartridge delivery system to act as a cushion prior to tapping the sinus floor. The hydrostatic pressure exerted by the putty results in an atraumatic

elevation of the sinus floor. CPS putty can be added in increments until the adequate elevation of the Schneiderian membrane is seen on IOPA X-ray.[44]

6. Transcrestal Guided Sinus Lift Technique (TGSL)

Introduced by Pozzi and Moy (2014), recommended for a residual alveolar crest of at least 5 mm in height and 5 mm in width distal to the canine.

- The virtual tri-dimensional implant positions and angulations and available bone height is determined with the help of a three-dimensional software planning program (NobelClinician, Nobel Biocare AG). The working length of each drill is equal to the ABH minus 1.0 mm.
- The data is sent digitally to a central production workstation (Nobel Biocare AB, Kloten, Switzerland) for the fabrication of the stereolithographic-generated surgical template, which registers the planned implant locations.
- A surgical occlusion index (Exabite II NDS, GC America, Inc.) is fabricated to register the vertical dimension of occlusion between the surgical template and the opposing dentition to enable accurate seating and positioning of the surgical template during surgery.
- A flapless technique is used through the stereolithographic template (Nobel Biocare AB).
- A partial-thickness mini-flap is reflected and each drill is used through the surgical template under copious irrigation to avoid overheating until the desired depth is achieved.
- Expanding-condensing osteotomes with a calibrated working length up to 26 mm, compatible with the Nobel Guide tooling are used through the sleeves of the surgical template.
- Careful, gentle tapping on the expanding-condensing osteotomes is performed to infracture the bony sinus floor.
- An average of 500 mg of grafting material mixed with an antibiotic solution is formed in the shape of the root and placed into the implant site using the final osteotome to act as a plugger.
- The implant placement is done through the guide sleeve of the surgical template.[45]

7. Alternative Method Dentium Advanced Sinus Kit (DASK)

The Dentium Advanced Sinus Kit (DASK) system is developed exclusively for maxillary sinus lift augmentation procedures, whether the classic Lateral Antrostomy approach or the transalveolar procedure is used.

This procedure has also significantly reduced the surgical time associated with sinus lift procedures as well as decreasing associated morbidities such as membrane perforations and tears.

- The distance from the alveolar crest to the sinus floor is measured in X-ray and drilling is done with DASK Drill #1 or #2 up to 1 mm short of the floor at a speed of 800-1200 rpm with internal irrigation.
- DASK Drill #3 is used to lift the sinus membrane facilitated by hydraulic pressure from an irrigation hole.
- DASK Drill #4 or #5 are used for a lateral approach using light pressure and rotating strikes.
- Sinus membrane elevators are used to gently release and lift membrane.[46,47]

Complications their Prevention and Management

Although sinus augmentation of the posterior maxilla is considered as a reliable and safe technique, it is still subject to some complications, The perioperative and postoperative complications and their proper management are discussed below:

Sinus Membrane Perforations

The most common complication involving sinus elevation is membrane perforation. The incidence of this occurrence has been reported to range 10-56%.verified by inspecting visually, elevated membrane movement while nasal breathing, radiographically visible leakage, and cautiously done Valsalva maneuver. Risk factors are bony septa, thin membrane, sinus pathology, overdrilling, or overfilling of graft materials.[48] Perforation management done by suturing with Vicryl 6/0, collagen wound dressing, absorbable collagen membrane or platelet-rich fibrin sealants based on the extent of perforations. It is sometimes necessary to stabilize this membrane on the surrounding bone using fixing pins or resorbable sutures.[49]

Hemorrhage/Bleeding

The arterial bleeding from the alveolar antral artery (AAA) is potentially a source of stress and complications for the practitioner and the patient. In case of bleeding, head elevation and direct firm pressure must be applied with a compress soaked with tranexamic acid for 15 min, Bone wax or grafting material into the AAA canal stops the bleeding. Electro cauterization or direct ligation is helpful in case of significant Haemorrhage.[50]

Buccal Bone Fracture

In these cases the mobilized buccal bone can be resorbed, exposing the implant surface; it is recommended to cover it with biomaterial and a membrane to let it heal properly. There is also a risk of losing the implant's primary stability. The implant should be removed and replaced after healing.

Infections Complications

Acute sinusitis is often related to perioperative anaerobic contamination, favored by superinfection of an insufficiently drained hematoma, or inadequate antibiotic coverage. Its prevention is based on strict aseptic conditions, use of bone grafts impregnated with metronidazole, and on appropriate antibiotic coverage, to begin in the preoperative phase or immediately postoperative.[48]

Endosinus Extrusion of Implant

Immediate expulsion of an Implant into the sinus is a rare and exceptional situation. Radiologic examination (CT scan) then extraction of the implant is performed under endoscopic guidance through middle meatotomy (for an implant located in the upper 2/3 of the sinus) through lower meatotomy or vestibular approach if the implant is situated lower. It is primordial to have a direct vision or through endoscopic guidance to avoid injury to the orbital floor.[51]

Conclusion

In selecting the treatment approach—lateral window or trans alveolar crestal technique—to perform maxillary sinus floor elevation, the clinician needs to consider the following factors.

- It is commonly accepted that a residual bone height of less than 4 mm warrants a lateral window sinus elevation approach without simultaneous implant placement.
- The length of the implant planned also influences the treatment approach. A disadvantage of the trans alveolar crestal technique is its limitations in elevating the Schneiderian membrane. Often, it is difficult to elevate the membrane more than 4–5 mm apically.
- Sinus lift procedure with grafting material is more successful with better long term survival rates than those without grafts.
- In both the lateral window technique and trans alveolar technique simultaneous implant placement together with sinus grafting is possible when good primary stability of the implant is achieved.

- Studies have shown that the trans alveolar approach in comparison to the lateral window approach is less invasive and of shorter surgical duration. However, the lateral window approach may be more appropriate in more advanced situations, such as severe resorption and multiple implant placements.[52,53]

Finally, it is difficult to provide clear indications with respect to whether the crestal or lateral SFE procedure should be adopted first. Ultimately, the decision is determined by the surgeon's judgment based on his experience and each clinical situation, with priority given to surgical interventions that are simpler, less invasive, with less risk of complications, and ultimately attaining goals within the shortest time frame.

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