

Sinus Lift

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ABSTRACT:

For more than 30 years the maxillary sinus augmentation graft has been a mainstay of implant-directed maxillary reconstruction. The purpose of this article is to review the fundamentals of maxillary sinus reconstruction including anatomy and physiology of the sinus, indications for surgery, preoperative evaluation, surgical techniques, and management of complications. While there are some relative contraindications for the procedure, there are almost no absolute contraindications. With preparation, education, and experience, the maxillary sinus augmentation/elevation graft is a procedure that greatly benefits the patient, with a predictable outcome. Sinus lift procedures are a commonly accepted method of bone augmentation in the lateral maxilla with clinically good results. Nevertheless the role of the Schneiderian membrane in the bone-reformation process is discussed controversially. Aim of this study was to prove the key role of the sinus membrane in bone reformation in vivo.

keywords.. bone augmentation, dental implants, posterior maxilla

INTRODUCTION:

Due to excessive pneumatisation of the maxillary antrum and atrophy of the maxillary ridge, floor of the sinus almost comes to lie very close to the maxillary alveolar crest. Maxillary sinus lift procedure is carried out to lift the floor of the sinus lining by placing a graft in between the maxillary antrum in the posterior aspect. It was introduced by DR OSCAR.H.TATUM Jr in 1970s^[1]

The various materials used for this surgical procedure are:

1. Iliac crest cancellous graft
2. Rib graft

3. Hydroxyapatite [2]

ANATOMY OF MAXILLARY SINUS:-

1. Maxillary sinus is the largest sinus in the head and neck region
2. SHAPE-Pyramidal with base towards the lateral wall of nose and apex toward zygomatic process of maxilla^[3]

Boundaries:

1. Apex : zygomatic process of maxilla.
2. Base : nasal surface of maxilla.
3. Roof : orbital surface of maxilla.
4. Floor : alveolar process of maxilla.
5. Anterior wall is related to infra orbital plexus of nerve and vessels and origin of muscles of upper lip.
6. Posterior wall is pierced by post. Superior alveolar nerve and vessels^[4,5]

ETIOLOGY OF DECREASED BONE HEIGHT:-

The maxillary sinus grows by a bone remodeling process named PNEUMATIZATION as age advances. This physiological process accompanied with increased tooth resorption due to tooth loss leads to decreased in bone height in the posterior maxilla^[7]

Indications:-

1. Partial defects of the vertical alveolar ridge.
2. Partial defects of horizontal alveolar ridge.
3. Alveolar insufficiency with sufficient basal bone^[8]

Contraindications:-

1. Cases of inadequate bone volume, especially in severe atrophic mandible with only basal bone with danger of fractures.
2. Osteoporosis.
3. Systemic or osseous disorders^[9,10]

Advantages:-

1. No visible scars.
2. No bone harvesting required.
3. Dental implants can be placed 3 months after surgery.
4. Shortening of the entire treatment time.
5. Precise positioning of the device.
6. Transport of vital alveolar bone, safe blood supply.
7. Less resorption.
8. No infection problem .
9. No periodontal problem.
10. Early vascularisation of new bone.
11. Teeth vitality remain intact^[11]

Disadvantages:-

1. Temporary nerve disturbance is possible.
2. A second intervention for removal of the distractor under local anesthesia is mandatory^[12]

Augmentation Technique:-

The type of maxillary sinus elevation and augmentation that a surgeon chooses to use on a given patient depends on the surgeon's preference as well as patient anatomy. Patient anatomical factors include the residual bone height and amount of lift desired. There are two main approaches for maxillary sinus floor elevation: Direct and Indirect approach. Direct –lateral window technique and indirect – osteotome sinus floor elevation, bone added sinus floor

elevation, minimally invasive transalveolar sinus approach, and antral membrane balloon elevation. But in this article, sinus augmentation using lateral window approach and osteotome sinus floor elevation are only described in detail^[13,14]

DIRECT/LATERAL WINDOW TECHNIQUE:

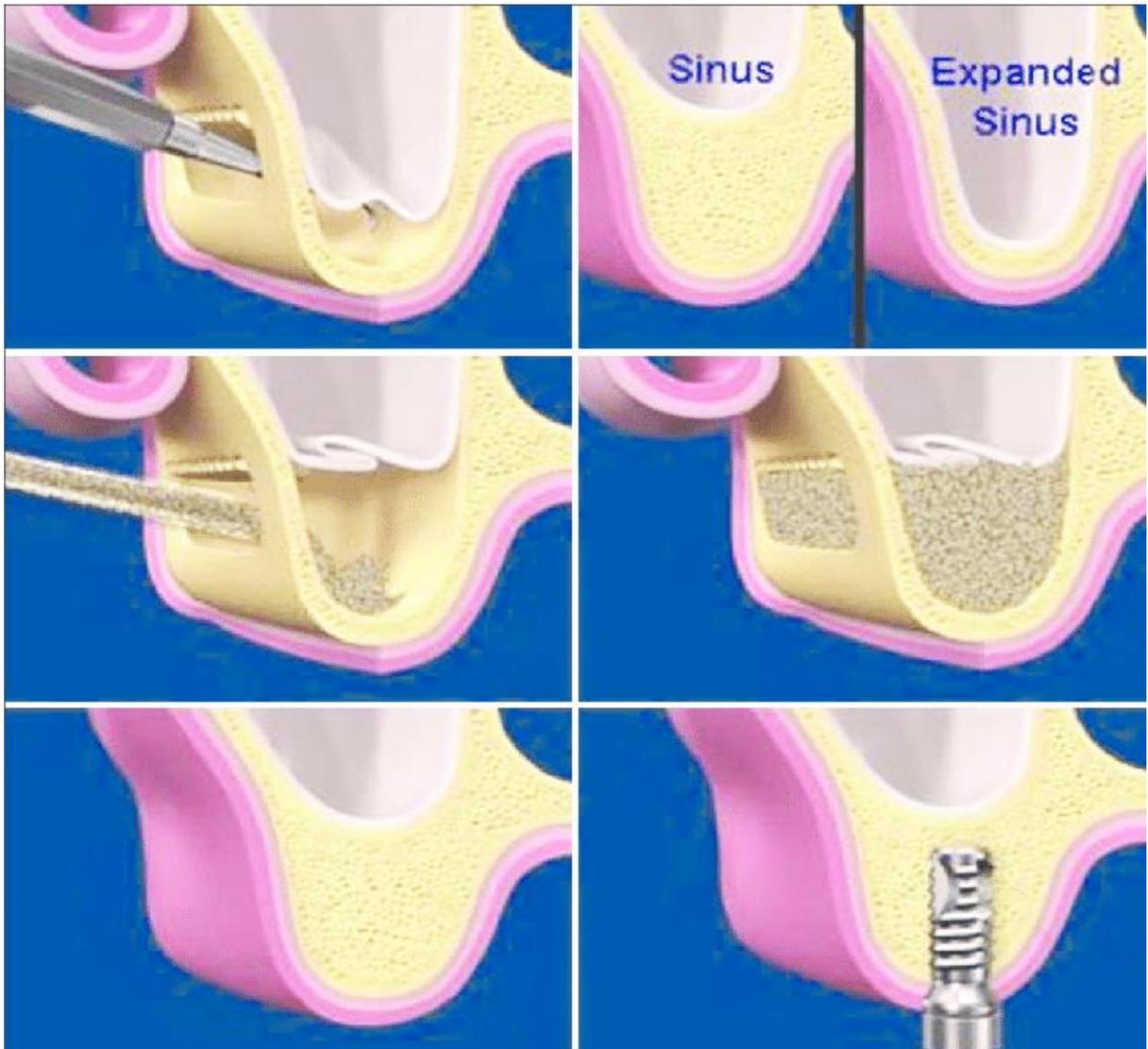
In this technique, sinus membrane is directly visualized and instrumented through the window created in the lateral wall of maxillary sinus.

Following are the steps of direct/lateral window technique:

1. **Anesthesia** – Infraorbital, posterior superior alveolar, greater palatine nerve block; subperiosteal anesthesia through slow infiltration (speed 1 ml/min)
2. **Incision** – Soft-tissue incisions must provide adequate room for creation of the lateral window. Anterior vertical incision should be at least 10–15 mm anterior to the wall of sinus to ensure soft tissue over the bone. Next, a mid-crestal ridge/palatal incision with 15C blade is made connecting the vertical incision. It is desirable to make the horizontal incision in keratinized tissue to facilitate suturing. Full-thickness flap is reflected to access canine fossa just below the infraorbital foramen, buttress of the zygomatic arch, and posterior lateral maxillary wall. While elevating full-thickness flap, the elevator must be adherent to the bone surface, so that the periosteum remains unchanged
3. **Lateral window/antrostomy** – After flap elevation, a sterile number 2 pencil is used to demarcate the outline of the lateral wall window on the buccal plate of bone. Position of the antrostomy is determined by the size and location of maxillary sinus. Coronal outline of the window will depend on the height of the graft, length of the implant to be placed, and location of posterior superior alveolar artery. Apical outline of the window should be approximately 3 mm above the sinus floor. Mesial outline of the window should be as close to anterior wall and distal outline will depend on the number of implants to be placed. Size of the window should be 20 mm mesiodistally and 15 mm apicocoronally which is sufficient to guarantee easy surgical access. When the surgeons experience level increases then he/she can easily elevate the membrane with reduced access and a smaller, more conservative access window can be made. This will retain a large source of blood supply to the lateral wall and enhance maturation of graft. High-speed handpiece with number 8 diamond bur is used to outline the window until bluish hue is visible with gentle brushing or paintbrush stroke. The shape of the window is usually oval and should not have sharp edges that may cause perforation of the membrane. Bone tampers are used to in-fracture the sinus bony access window. Antrostomy can either be elevated or completely removed. It is elevated when there is good surgical access and the thickness of the cortical wall is <2 mm. It is completely removed when surgical access is difficult, in the presence of septa and in shallow sinus.
4. **Sinus membrane elevation** – Detach the sinus membrane with blunt instrument. Elevation should be preceded only when the membrane detaches. Membrane should be elevated carefully starting on the sinus floor and then extending to the anterior and posterior walls with the help of sinus curettes. The final elevation is up to the medial wall to the full height of the expected graft placement. Sinus membrane integrity can be tested by asking the patient to breathe in deeply while observing the membrane lifting
5. **Preparation of implant site** – If there is minimum of 3–4 mm of residual crestal bone of good quality, it is possible to place implants simultaneously or else place the implant after 4–6 months. Since the maxillary bone is a low-density bone, undersize the implant osteotomy site. Protect the sinus membrane with periosteal elevator to avoid damaging with drills
6. **Graft placement** – Sinus membrane should be protected with collagen membrane. Implants are placed in the prepared implant sites. Bone grafts are placed in the least accessible area first. Anterior and posterior recesses are filled first followed by the area along the medial sinus wall. Do not compact the bone graft too tightly as it prevents vascularization. But some authors

showed that sinus lift can be performed using the lateral approach with whole blood as the sole filling material with promising results. Thus, sinus augmentation with simultaneous implant placement can be done using platelet-rich fibrin as a sole grafting

7. **Membrane placement** – Resorbable membrane is placed over the window (collagen membrane adheres over the bone which does not require fixation screws and does not require removal)
8. **Suturing/incision closure** – Nonresorbable monofilament suture and horizontal mattress sutures are used to suture the flap (does not require any advancement).^[15,16]



Direct/Lateral Augmentation Technique

INDIRECT/OSTEOTOME TECHNIQUE:

Following are the steps of osteotome technique:

1. **Anesthesia**
2. **Incision** – crestal incision should be extended distally in some cases, to the tuberosity area where autologous bone needs to be harvested
3. **Flap** – to expose ridge crest, full-thickness mucoperiosteal flap is elevated

4. **Drilling** – start the osteotomy preparation with pilot drill of 2 mm diameter keeping it 2 mm short of the sinus floor. Here, confirmatory radiograph should be taken by inserting pilot drill. Either the widened drills or set of osteotomes of varying dimensions can be sequentially used to widened the osteotomy site to the same level, i.e., 2 mm short of sinus floor. In low-density bone (D3 and D4), osteotomes are preferred to laterally condensed the bone and to enhance the density of the bone
5. **Grafting** – once the largest osteotome has expanded the implant site, particulated bone substitutes (mixed with autogenous bone) are added to the osteotomy as the grafting material. Composite bone graft composed of 25% autogenous and 75% hydroxyapatite graft should be preferred. Graft is inserted in the osteotome site, before the in-fracture of the sinus floor
6. **Fracture** – an osteotome of lesser diameter than the implant body is inserted in the prepared osteotomy site and tapped gently to fracture up the sinus floor. Look out for the change in sound while in fracturing the sinus floor. When sinus floor fractures different pitch of sound can be heard
7. **Sinus floor elevation**– This is done by reinserting the largest osteotome in the implant site with the graft material in place. The added bone graft exert pressure onto the sinus membrane which elevates it further. Bone graft can be added and tapped to achieve the desired amount of sinus membrane elevation. Do not exceed the stretching limit of the membrane.
8. **Implant placement** – Implant fixture to be placed should be slightly larger in diameter than the osteotomy created by the final osteotome^[17]

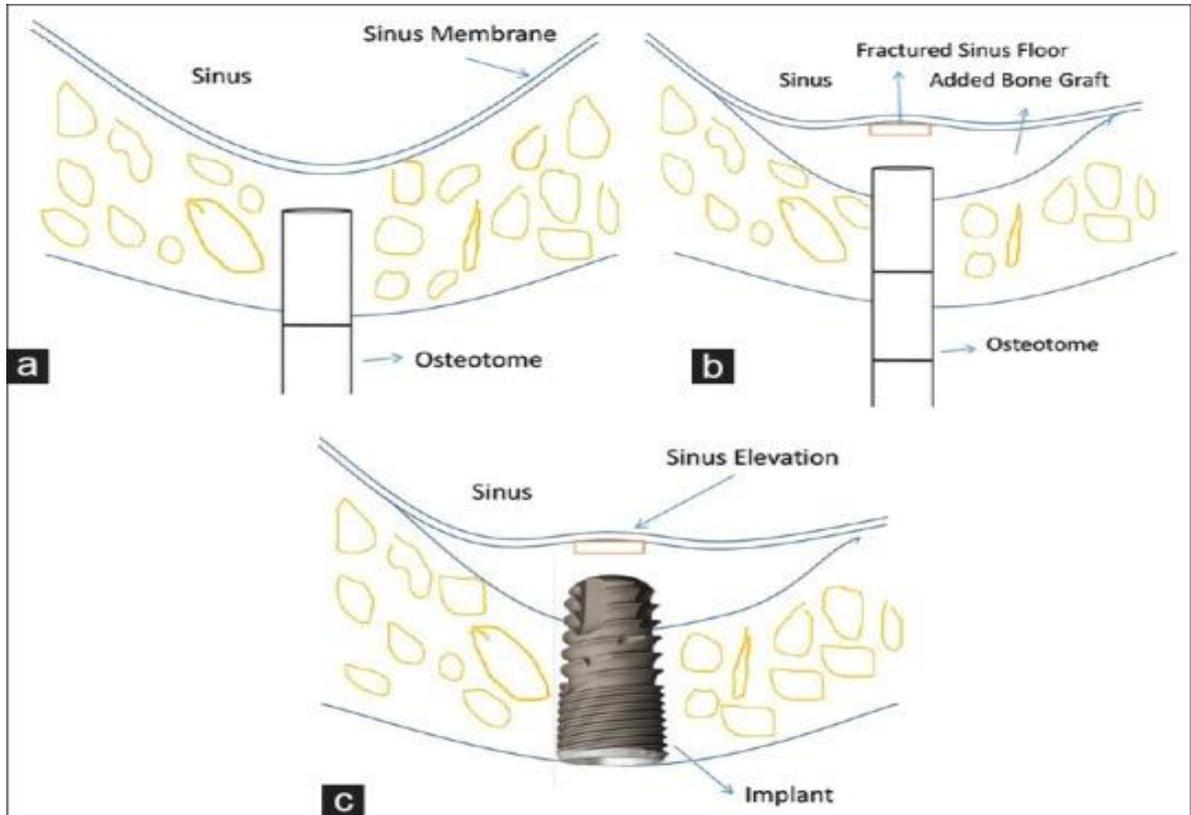
Minimally Invasive Techniques:

Other minimally invasive techniques for sinus augmentation have been introduced over the years. Modified trephine/osteotome technique was described in 1999 was modified by the simultaneous insertion of implants. The implant site is prepared using a 3 mm exterior diameter trephine bur at a distance of 1–2 mm from the sinus floor. Bone cylinder is then pushed apically to a depth of 1 mm less than the one made with the bur, using an osteotome of the same diameter as the trephine bur. The final preparation of the implant site is carried out using osteotomes of increasing diameters, always inserting them to the same depth. The implants are inserted at a speed of 30 rpm, causing controlled lateral movement of the bone cylinder inside the space created by the movement of the sinus membrane.

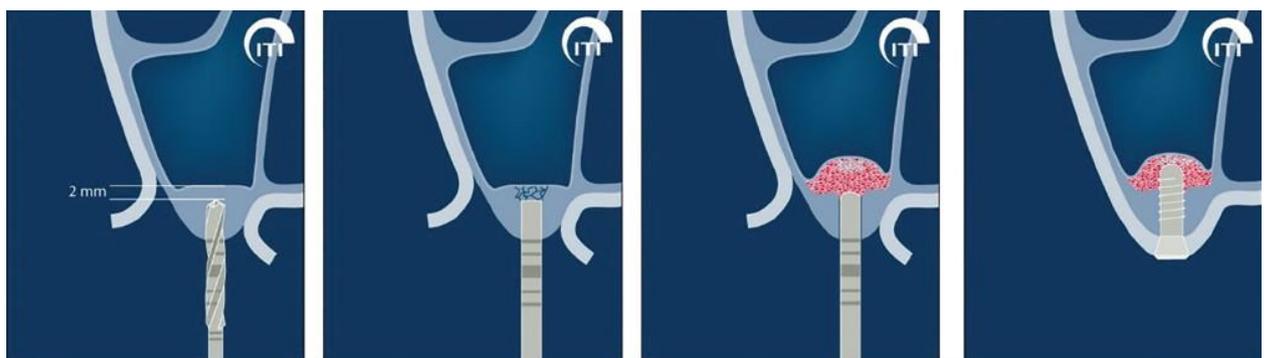
Antral membrane balloon elevation procedure was given by Soltan . in 2012. This technique uses inflatable balloon to elevate the sinus membrane. The Zimmer sinus lift balloon was designed to lift the sinus membrane gently and evenly. This technique has been shown to reduce the chance of sinus membrane perforation. There is a metal shaft with a tip connected to a latex balloon which has the inflation capacity of approximately 5 cm. For lateral window approach, angled design of balloon and for a crestal approach, the straight design balloon is used. There is popular micro-mini design also available which can be used for either of the approaches. Before the balloon is inserted, the osteotomy is enlarged to 5 mm. Osteotome of 5 mm is used to break the sinus floor after the addition of bone. The sleeve of the balloon is then inserted 1 mm beyond the sinus floor. The saline is injected slowly from the syringe into the balloon so that the balloon would inflate progressively. The desired elevation is determined by deflating the balloon and the process is again repeated till the desired sinus elevation. One cubic centimeter of saline is expected to raise 6 mm of the membrane.

Minimally invasive transalveolar sinus approach (MITSA) elevation technique was given by Kher. 2014. In this procedure, calcium phosphosilicate putty is used for hydraulic sinus membrane elevation. Drilling is done 1 mm short of the sinus floor and osteotomy completes till the last drill. Concave 3 mm osteotome is used to in-fracture sinus floor. Novabone gun cannula fits snugly in prepared osteotomy. The material gently lifts membrane due to its consistency. Thereafter, implant is placed. MITSA technique is minimally invasive as this technique uses

osteotome only once so is less traumatic to the patient. Minimally invasive transcresal-guided sinus lift technique was given by Pozzi and Moy. This is a new procedure with computer-guided planning and a guided surgical approach to elevate the maxillary sinus. The use of computer-aided design/computer-aided manufacturing generated surgical template in combination with expander-condensing osteotomes, make this surgical technique minimally invasive.^[18,19]



Bone-added osteotome sinus floor elevation (a) osteotome instrumentation by malleting (b) fractured sinus floor and added bone graft in osteotomy (c) sinus elevation with simultaneous implant placement



INDIRECT/OSTEOTOME TECHNIQUE

Post Operative Instructions And Care:

1. On first night after surgery, head should be elevated on 2 or more pillows
2. Liquid diet for 2 days and then soft diet for 2 weeks
3. Some nasal bleeding may occur during first day

4. Medications – Amoxicillin with clavulanate potassium 625 mg BID for 10 days; ibuprofen 600 mg and acetaminophen 500 mg QID for 3 days; oxymetazoline nasal spray for 7 days; 1.2% chlorhexidine mouth 30 cc BID for 14 days
5. Avoid chewing from the surgical site, blowing the nose for 2 weeks, smoking, balloon blowing, sucking liquid with straw, flying in pressured aircraft or scuba diving, carbonated drinks (minimum 3 days), heavy lifting of weights, and playing musical instrument that require blowing. Actions that create negative pressure (blowing of nose or sucking through straw) must be avoided by the patient during the first week after surgery. If the patient does sneeze, he or she must keep the mouth open, so that the pressure is not exerted within the sinus
6. Swelling – some bruising, facial swelling expected underneath the eye. Apply ice packs over the face; 10 min on and 10 min off.^[20]

Complication And Management:

Sinus membrane perforation is the most common intraoperative complication, which occurs in 7%–35% of sinus augmentation procedures. Factors that affect sinus membrane perforation during osteotomy include vigorous instrumentation during elevation and thickness of the sinus membrane. Sinus membrane perforation increases rates of postoperative sinusitis and graft failure. Vlassis and Fugazzotto proposed a classification system for elevation and treatment. If a membrane is perforated when creating the lateral window outline, the osteotomy is extended several millimeters beyond the original window to reestablish contact with the intact membrane. If membrane perforation occurs during the lifting of sinus membrane and is a small defect of <2 mm it can be left to heal itself but if the perforation is more than 2 mm, the opening can be patched with a piece of hydrated resorbable collagen barrier that's large enough to cover the tear by several millimetres.

Bleeding can occur while performing an osteotomy. Bleeding from the sinus membrane can be controlled by placing gauze soaked with anesthetic solution containing 1:80,000 epinephrine directly onto the membrane. Bleeding from the bone requires application of direct pressure with an artery forceps, or it can be managed with a cautery unit. Another method for containing an intraosseous arterial bleeder is to displace the membrane and compress the bone with a mosquito hemostat, thereby crushing the bone and obstructing the bleeding blood vessel.^[21]

Dislodgement of implant into sinus can occur several days postimplantation, at abutment connection surgery, or years later. This may be due to positioning of implant in an unnecessary apical position or excessive pressure during placement or widening of the ridge due to overdrilling. Thus, careful treatment planning, patient selection, and the appropriate sinus augmentation technique are essential to minimize the risk of implant displacement into the maxillary sinus. Once the displacement is diagnosed and located in computed tomography scan/orthopantomogram, the implant must be removed as soon as possible.

Other complications are related to the presence of preexisting antral pathologies, such as rhinosinusitis, odontogenic sinus diseases, pseudocysts, retention cysts, and mucocoeles.^[22]

CONCLUSION:-

The primary method of long-term evaluation of sinus grafts has been evaluated based on the implant survival. Implants placed with sinus lift grafts had shown superior results than those placed without grafts. Literature search on the decision of sinus lift procedure suggests that angulated or short implant success rates are unpredictable and recommends sinus lift technique as a valid procedure to increase RAB height up to 5–9 mm. The procedure of direct or indirect sinus lift technique needs sound knowledge of sinus anatomy, proper preoperative evaluation, diagnosis, proper surgical techniques, regular recalls, and review.

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