



Review on Indications and Technique for Maxillary Sinus Augmentation for Implant Placement in Maxilla

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ABSTRACT

The dental implant has grown in popularity since 1970's as an alternative to replace the missing teeth. Implant placement in the posterior edentulous maxilla is a challenging task in dentistry due to atrophied maxilla & sinus pneumatization. In these conditions the height in between the sinus floor & the alveolar ridge can be greatly extended by the sinus augmentation procedures. The sinus augmentation procedures have been invented in the mid 1970's. This article explains about the various techniques of sinus augmentation and its indications in detail with review of the techniques.

Keywords: Edentulous, pneumatization, augmentation, atrophied, implant.

INTRODUCTION:

The maxillary sinuses were initially depicted and described by Leonardo da Vinci in the year 1489, and they were later characterised by English anatomist Nathaniel Highmore in the year 1651. The largest and first to form of the paranasal sinuses is the maxillary sinus, also known as the antrum of Highmore, which is located inside the maxillary bone. The maxilla's alveolar system supports the dentition and serves as the sinus's minor border. [1]

Maxillary sinus floor augmentation, also known as sinus lift, sinus graft, sinus enhancing, or sinus procedure, is a surgical procedure that elevates the sinus (Schneiderian) membrane from the underlying sinus wall and inserts a bone graft beneath it to increase the amount of bone in the posterior maxilla. Bone for a dental implant is obtained by sinus enlargement. Implants can be used concurrently with sinus surgery (simultaneous placement) or postponed until after the healing process is complete (delayed placement).[2]

MATERIALS AND METHODS:

A PubMed, NCBI, google scholar, indian journal of dental sciences and google search was undertaken on the terms of maxillary sinus augmentation, sinus lift procedures, graft materials for sinus lift procedures. The review was limited to studies published in english over last 20 yrs from the year of 2000 to 2022.

ANATOMY:

During childhood, the maxillary sinus expands quickly until it reaches the level of the floor of the nose. It could go as far as 10 mm below the nasal floor. The inferior margin of the maxillary sinus is closely associated with the apexes of the maxillary premolars and molars. The orbital floor forms the roof of the maxillary sinus, which extends to the premolar region at the anterior boundary.[3]

ANATOMICAL CONSIDERATIONS:

Age-related pneumatization is the constant rise in maxillary sinus volume. It typically develops in a downward direction and is frequently accompanied by tooth loss, such as the loss of maxillary premolars or molars. After tooth extractions, maxillary sinus pneumatization is said to increase. The area's alveolar bone loss poses a special challenge for implant placement after extraction. The alveolar bone may eventually thin to an excessive degree as a result of pneumatization, leaving insufficient bone in the area designated for dental implants. Due to the resorption process after tooth removal, the vertical bone loss may only happen between the alveolar ridge crest and sinus floor. Additionally, it could happen due to enhanced osteoclast activity on the periosteum side of the Schneiderian membrane, maintaining the level at the alveolar ridge crest with continued resorption beneath the sinus floor, or a combination of the two. Additionally, the posterior maxillary region's low density may be a factor in all of these resorption processes, leading to alterations

in contour or dimension. Successful prosthetic rehabilitation requires taking into account the interocclusal distance, prosthetic planning, anticipated implant height and width, as well as the density of the residual bone. The morphology of a bony deficiency must be taken into account while choosing an augmentation technique. The maximum elevation level of the membrane is determined by the sinus volume and the height of the semilunar hiatus. The sinus ventilation may be hampered by an extensive buildup of grafting material. All these factors are used to determine how much sinus volume is required to raise the sinus floor.[3]

FUNCTIONS OF MAXILLARY SINUS:

The functions of maxillary sinus are, imparts resonance to the voice,Increases the surface and makes the skull lighter,Moistens and warms the inspired air,Filters out the inspired air debris,Mucus production and storage,Limit the extent of face injury from trauma,Provides thermal insulation to important tissues,Serves as an accessory olfactory organ'

Indications:

Maxillary sinus pneumatization

Inadequate residual bone height

Atrophic posterior maxillary alveolus

Contraindications:

Acute sinus infection

Recurrent chronic sinusitis

Severe allergic rhinitis

Neoplasm

History of radiation therapy of maxilla

Severe sinus floor convolutions

Uncontrolled diabetes mellitus

Alcoholic & heavy smoker

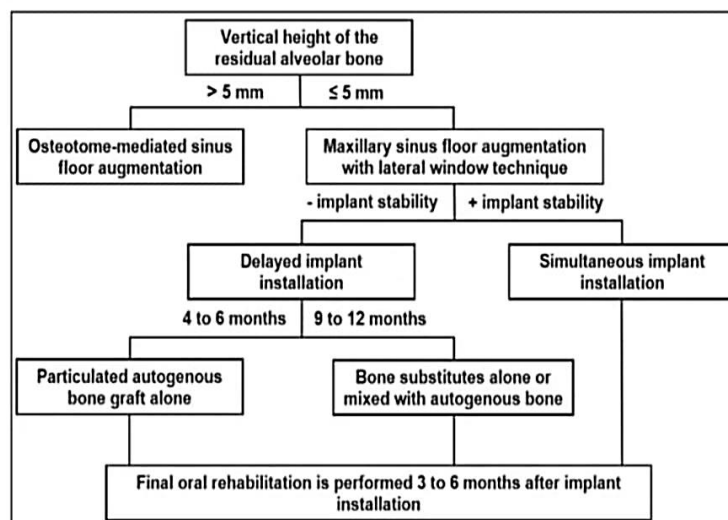
Psychosis

CAUSES FOR INSUFFICIENT BONE HEIGHT:

Pneumatization & atrophy of bone in edentulous area,Cantilever bridge,Implants mesial & distal (tuberosity region) to the sinus area & bridge placement
A combination of long & short implants.

(4)

DECISION TREE FOR MAXILLARY SINUS ELEVATION OPTIONS



TECHNIQUES:

- The augmentation may be obtained either by placing the material in direct contact with the membrane or by creating a new cavity using a sinus partitioning technique..
- The type of maxillary sinus elevation and augmentation procedure is decided by the surgeon, by the patient preference as well as the patient's anatomy.
- There are two main approaches for sinus floor elevation they are;
 - I. Direct approach
 - II. Indirect approach

DIRECT APPROACH:

- a) Lateral window technique
- b) Caldwell luc technique (vercellotti et al)

INDIRECT APPROACH:

- a) Osteotome technique
- b) Maxillary sinus balloon lifting
- c) Hydraulic sinus lift technique
- d) Intra lift technique
- e) Reamer mediated sinus floor elevation
- f) Osseodensification technique

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.(5)
- **Handling of the sinus membrane:**
 1. Gently detach the membrane at the apical aspect of the sinus cavity and then the mesial and the distal aspects
 2. After initially releasing the lower border, mesial, distal aspect and upper border of the sinus membrane about **3-5 mm**
 3. Go further from the lower aspect of the sinus cavity to separate all the way to the medial wall
 4. it is important to ensure that the3 membrane is lifted high enough to place the appropriate implant length(6)

With graft material:

The **graft material** is densely packed around the exposed implant surface to facilitate **De novo bone formation** ,the lateral window is covered by the **resorbable collagen membrane** to prevent in growth of fibrous tissue before the muco-periosteum is readapted and sutured if stability is compromised then the implants are inserted **4-12 months** after augmentation final prosthetic solution is performed (5)

Without graft material:

Introduced by **Lundgren et al 2004**.Requires sufficient vertical height to achieve primary stability, since immediate implant installation is necessary to preserve & support the elevated Schneiderian membrane.

A blood coagulum is formed around the exposed implant tip in the secluded compartment between the elevated and the original floor.

The lateral window to the sinus is covered by a resorbable collagen membrane.The muco-periosteum is readapted & sutured.Final prosthesis-performed 3 to 6 months after elevation &implant installation, when de novo bone is formed around implant.(7)

ADVANTAGES:

- It is clear
- Easy access
- Loading of implant can be immediate
- More efficient work is done

DISADVANTAGES:

- More pain
- More post-op discomfort
- Time consuming
- Needs highly efficient practitioner
- More susceptible for infection

COMPLICATIONS:

- Perforations
- Bleeding
- Migration of dental implants into maxillary sinus
- Postoperative infection
- Sinusitis
- Exposure of graft
- Graft loss
- Oedema
- Seroma formation
- Benign paroxysmal positional vertigo
- Exposure of the collagen membrane(8)

INDIRECT APPROACH:**OSTEOTOME-MEDIATED ELEVATION**

Trans crestal sinus lift approach – **Tatum 1986 1994 summers** – **set of tapered osteotomes** with increasing diameters intended to increase the density of the soft bone and create the **fracture of the maxillary sinus floor**. Schneiderian membrane & the maxillary sinus floor is elevated from a **trans crestal** approach using osteotomes creating a compartment for graft placement or blood clot formation, without the preparation of a lateral window. Implants are inserted immediately to support the elevated floor of the maxillary sinus with the Schneiderian membrane.

Most suitable for installation of **single implants**.(9)

COMPLICATIONS:

Perforation of the sinus

A oblique sinus floor, sinus septa, root apices penetrating into the maxillary sinus.

Postoperative infection

Disoriented after surgery

Nose bleeding

Blocked nose

Positional vertigo(10)

SINUS LIFT BALLOON

The **ZIMMER** 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 1cc of saline, which is used to inflate the balloon, equal to 1cc of graft material. On average, with **1cc of saline** the sinus lift balloon may elevate the sinus membrane **6mm**. Angled design is used for lateral window and Caldwell approach. Straight design is used for trans crestal / summers approach(11)

HYDRAULIC SINUS LIFT

To remove and loosen the Schneiderian membrane, the uncontrolled hydraulic pressure is introduced into the osteotomy site using an uncontrolled water jet or air/water exhaust spray from the handpiece. Without controlling the direction & intensity distribution of hydraulic pressure, sinus membrane perforations may still occur, pressure is directed against the apex of the “tent” being created.

To provide suitable equal distribution of hydrostatic pressure,” controlled **hydrostatic sinus elevation**” was introduced- “**lifting pressure**” that simultaneously places equal force per square millimetre of bone -membrane interface.(12)

ADVANTAGE:

- Minimally invasive surgical procedure
- The osteotomy is minimal being 1-3mm deep & wide
- Minimal instrumentation with closed graft delivers permits a sterile technique
- The procedure's simplicity necessitates less time and expertise.

DISADVANTAGE:

- After three months, it is advised to immediately load the implants.
- Blind procedure
- More chance errors to occur

COMPLICATIONS:

The complications include, Acute sinusitis ,Flap dehiscence ,Over-filling necrosis, Oro antral fistula ,Migration of implants into the sinus cavity ,Cyst formation.(13)

POSTOPERATIVE INSTRUCTIONS:

- Do not blow your nose
- Do not use tobacco
- Do not drink with straw
- Never pull or elevate the lip to inspect the stitches. sneeze with opening your mouth

DISSCUSSION:**LITERATURE REVIEWS:****BASED ON THE TECHNIQUE**

TECHNIQUE	STUDY CHARACTERISTICS	IMPLANT SURVIVAL
Lateral window technique	85 Studies, 4807patients ,14944 implants after 12 to 107 months loading	Machined implant surface:61.2% to 100% Rough implant surface: 88.6% to 100%(14)
Trans-crestal technique	18 studies,1096patients ,1744implants, after 12 to 64 months loading	83% to 100%(14)

BASED ON BONY SUBSTITUTE & AUTOGRAFT MATERIAL

Lateral window technique	Study characteristics	Implant survival
Bony substitute only	19 studies,740 patients, 2481 implants, after 12 to 107 months loading	82% to 100% Excluding smooth surface:88.6% to 100%(14)
Autograft only or combined with bone substitute	36studies ,1210 patients ,4218 implants, after 12 to 107 months of loading	61.2% to 100% Excluding smooth surface: 96% to 100%(14)

CLINICAL OUTCOME:**Direct technique:**

Implant survival rate beyond 90% - SilvaLD-2016(15)

Moreover an implant survival of 99% has described in a 1-6 years follow up study by cricchio G,2011(10)

However only 14 implants inserted in 6 patients were followed for 6 years- cricchio G -2011.(10)

Indirect technique:

Overall implant survival rate more than 90% -Shi JY 2016(16)

No statistically significant difference with or without the use of a graft material -Chen MH 2017(16)

A 10-yr old implant survival rate of 100% without the use of a graft material(17)

The implant survival rate- higher when the residual vertical bone height is more than 5mm- Del fabbro M 2012(18)

Installation of short implants (less than 6mm) in conjunction with osteotome-mediated sinus floor elevation significantly diminished the implant survival rate- Lang NP 2000.

CONCLUSION:

The placing of implants in maxilla is prohibited by the maxillary sinus becoming pneumatized as a result of posterior maxillary tooth loss. Regenerating lost osseous structure in the posterior maxilla is expected after maxillary sinus elevation and augmentation. This provides the patient with numerous benefits for long-term implant site success.(5)Based on implant survival, the main approach of long-term evaluation of sinus grafts has been assessed. Implants inserted with sinus lift grafts produced better results than implants inserted without them.(19)There are numerous indirect sinus lifting procedures that differ from the lateral approach technique in terms of greater safety and predictable success rates during case selection appropriate for particular techniques.(20)

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