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Techniques and Graft Materials Used in Maxillary Sinus Lift Procedure for Dental Implant Placement

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ABSTRACT

Posterior quadrant of the maxilla consider as special challenges for use of implant active prostheses to restore dental function. Placement of Implant in the posterior part of maxilla influence hesitation due to the lack of sufficient alveolar bone height. This occurs due to the proximity of alveolar crest to the maxillary sinus because of sinus pneumatization, along with resorption of bone of the alveolar ridge secondary to tooth extraction, pathological lesion or trauma. Sinus lifting to augment atrophic maxillary posterior area to create space for implantation has been progressively widespread in latest years. In literatures 2 approaches have been designated for sinus lifting: the direct approach called also lateral approach and the indirect approach called also crestal approach.

Keywords: Grafting material, lifting technique, sinus anatomy, sinus lifting.

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I. Introduction

Posterior quadrant of the maxilla consider as special challenges for use of implant active prostheses to restore dental function. Placement of Implant in the posterior part of maxilla influence hesitation due to the lack of sufficient of alveolar bone height. This occurs due to the proximity of alveolar crest to the maxillary sinus because of sinus pneumatization, along with resorption of bone of the alveolar ridge secondary to tooth extraction, pathological lesion or trauma. Accordingly, restriction in length of dental implant, also poor bone density in the posterior maxillary region, which can furthermore cause decreasing of implant success rate [1].

Numerous treatment options are suggested during implant placement in the maxillary posterior jaw to overcome inadequate amount of bone. the main conservative treatment option: short implants to avoid the maxillary sinus. Other option of avoiding the sinus: inclined implants in a remarkable position medial or distal to the sinus if there are suitable bone quantity. Furthermore, extra-long implants "basal implant" are often placed within the zygomatic bone in order to avoid sinus. There are techniques that lifting the sinus floor considered typical surgical modality to correcting the insufficiency of bone. This procedure has been identified in literature as sinus augmentation or sinus lifting [1].

Sinus lifting to augment atrophic maxillary posterior area to create space for implantation has been progressively widespread in latest years. in literature 2 approaches have been designated for sinus lifting: the direct approach called also lateral approach and the indirect approach called also crestal approach, both with one and two staged [2].

Even that sinus augmentation and implant placement are popular now, un fortunately surgical complications occurs and reported within the literature, These complications manuscript Click here to view linked References occur equally with each lateral as well as crestal approach. As result, practitioner should understand all details, the indication and reason of sinus lifting and additionally when we should choose and when not to choose sinus lifting [3].

This literature will overview the maxillary sinus and treatment options for Dental Implant placement in the posterior maxilla.

II. Literature Review

A. Biologic and Anatomic Considerations

1) Morphology & Anatomy

The maxillary sinus or the antrum of Highmore, is that the largest of the facial sinuses. It's set simply lateral to the nasal and inferior to the orbit [4]. The cavity is lined with pseudostratified columnar epietheleum called: Schneiderian membrane, named by a German expert in the seventeenth century, it's a mean thickness 0.8 mm [5]. The sinus undergoes pneumatization during the course of childhood and reaches position parallel to the nasal base by age 12-13. Pneumatization is then complete by age twenty and is on the average five millimeter inferior to the nasal floor [6].the shape of sinus is a quadrilateral pyramid, An additional oblique angle shaped by the lateral and medial sinus walls, typically seen within the tooth region, will influence the chance of perforation during elevation of the Schneiderian membrane [7]. The sinus drains into the nasal cavity via the sinus ostium, that is found on the posterior-superior side of the medial wall and is just about 2.4 millimeter in diameter [8].

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The sinus varies greatly in size, form and position among people, on the other hand it vary between sides of a similar individual [9].

It is pyramidical in form having a base, an apex and 4 walls:

- The base: lateral wall of the sinus.
- The apex: laterally in the direction of the attachment of the jaw.
- The four walls:
  a) Facial surface of the jaw forms the Anterior wall.
  b) Infratemporal surface of the jaw forms the posterior wall.
  c) Floor of the orbit form the roof.
  d) Extension of the jaw form the floor.
- The opening of sinus that communicates with the center of meatus is termed ostium. It 3-6 millimeter in diameter and is found in hiatus semilunaris.
- The sinus might have septa that partly divide it into intercommunicating compartments with separate ostia is also found.
- The average capability of the sinus is concerning 15 ml. and its average dimensions in centimeters square measure 2.3 transversally, 3.4 antero-posteriorly and 3.35 vertically [10].

2) Septa

The presence of septa will increase the chance of membrane perforation [7]. Septa within the sinus were initial demarcate by [11]. Complete (primary) or incomplete (secondary) septa preset. in an series of a 100 cases, Zijderveld found a prevalence of septa in 48% of cases [7].

15 different previous studies by computed tomographic (CT) found a large variation of prevalence of septa up to 58%. [12] Their orientation might vary within the mesial or mesio-lateral directions, which have an effect on the surgical approach.

Mesio-lateral septa or multiple septa typically best for lateral approach from a lateral approach; whereas mesial septa is managed from a crestal or lateral approach [13].

3) Mucosa

The maxillary sinus is lined with a mucosa the same of the respiratory tract. On the other hand, it is slightly thinner than mucosa that lining the nasal cavity. The antral mucosal membrane is formed of [13]:

- An epithelial layer above the basement membrane.
- A subepithelial layer of connective tissue.

4) Thickness of The Schneiderian Membrane

Normal membrane thickness about: 0.8 mm [14], in [15], during a study of 50 patients, found a powerful association between thick gingival phenotype and thicker Schneiderian membrane, and a moderate association between height of residual ridge and thickness of membrane. Reference [14] reported that membrane perforations were correlated with overly thin (0.3 mm) membranes.

B. Blood Supply & Nerve

1) Arterial Blood supply

The arterial blood supply to the lateral aspects of the sinus comes from the posterior superior alveolar (PSA) artery and infraorbital (IO) artery. The greater palatine artery supplies the rest of the sinus [16].

2) Venous Drainage

The venous system is drained either by:

a) A single venous trunk, through the spheno-palatine vein. By three venous plexus: the pterygoid plexus (anterior and posterior), in addition to the
b) alveolar plexus. which drains into the maxillary vein and then facial vein [16].

3) Innervation

Infraorbital (the 2 branches: anterior and middle superior alveolar nerves) and posterior superior alveolar nerves supply The innervation to maxillary sinus [9], most sensory innervation is provided by the posterior superior alveolar nerve. The anterior superior alveolar nerve innervates the anterior portion, whereas the middle superior alveolar nerve innervation secondary tissue layer innervation. Greater palatine nerve innervated the ostium while anterior ethmoidal branch of the ophthalmic nerve (V1) is innervated the rest of the sinus. Parasympathetic secretomotor fibers innervate sinus mucous membrane from the sensory branches of fifth cranial nerve [9].

C. Clinical Assessment of Maxillary Sinus

Clinical examination of the patient

- By tapping on the lateral walls of the sinus from outside, over the cheekbones prominence and intraoral palpation on the lateral surface of the maxillary jaw between the zygomatic buttress and canine fossa [13].
- By transillumination of the sinus: is application of a bright light against the mucosa of the sinus on the palatal or facial sides and detecting the transmission of light through the sinus in a darkened room [13].

D. Radiographic Evaluation of Maxillary Sinus

1) Panoramic (Ortho-Pantamo-Graph) (OPG)

It's particularly helpful within the early diagnostic part, to detect any pathologic conditions. But with magnification so it is not use for the accurate surgical measurements for lateral or crestal sinus floor augmentation [17], that consistent with [18], because there's a risk of misdiagnosis so that OPG not used alone or as an alternative of CBCT.

2) CBCT

A CBCT examination of the jaw anatomy is often requested to judge the requirement of a surgical sinus lifting for implant placement within the posterior jaw. Essential findings like tissue layer thickening of a sinus, height of the jaw, dimension of the area or obstruction which may impact on the clinician's treatment choices [13].

3) Magnetic Resonance Imaging (MRI)

Reference [19] initial delineated the employment of MRI for the sinus lifting in 1999 and used as an alternate to the CT that exposes the patients to extreme dose of radiation. Reference [20] additionally examined assessments of the bone graft capacities needed for a wanted vertical bone height pre-operatively by MRI. Reference [21] used the MRI to measure the vertical bone height for sinus lifting procedure.

4) Endoscopy

The endoscopy has been essentially applied to trans-nasal elimination of the implant [22]. However some surgeons takings benefit of endoscopy for experimental purposes, it has not been used widely in implantology.

E. Sinus Grafting

The ideal bone graft material ought to have each osteoinductive and osteoconductive properties and having ability for osseointegration to the surface of implant. These properties differ in numerous bone grafting materials. Osteoinduction is delineated as "primitive, undifferentiated and pluripotent cells that are stimulated by an inductive means to become bone-forming cells and osteogenesis is induced" [23].

Osteoconduction means that bone develops on a surface. An osteoconductive surface licenses bone progression on the surface and also into the pits and holes. The grafting material that used in maxillary sinus lifting is estimated to permit new normal bone creation with ability to penetration and to afford the exchanging the bone graft material by natural bone that supportive to the implants with suitable bone bulk [23].

F. Techniques to Augment the Maxillary Sinus

1) Closed Sinus Augmentation or Crestal Approach

Several techniques routinely used for closed sinus floor elevation are:

a) Osteotomy technique with or without grafting
b) Osteotomy technique with or without immediate implant placement
c) Osteotomy technique with immediate insertion of implants without grafting [1].

2) Osteotomy Technique with or without Grafting

The osteotomy sinus lifting technique seeks to lift the sinus floor using the bone taken from preparing the osteotomic location. This technique is used when there is at least (3-5) mm of bone overlying sinus floor. Different authors have introduced modifications to this known approach for maxillary sinus augmentation since the original approach described by [1]. The osteotomy of endosteal dental implant is prepared according to detected bone density. The penetration of the osteotomy must be around (1 to 2) mm away from the floor of the sinus. Reducing the speed of the handpiece (lower than 1000 rpm) improves tactile sensation and permits the surgeon to feel the cortical plate of the antral floor and prevent its penetration with a rotary drill. Osteotomy is prepared to the suitable diameter according the traditional procedure. Then a flat-end or cupped-shape osteotomy of the equal width as the final osteotomy is carefully chosen [10]. The osteotome is place in and tapped steadily into final location up to 2 mm beyond the prepared implant osteotomy into the sinus. Six months after the surgical procedure (in D2 and D3 bone, or 8 months in D4 bone), a radiograph will reveal bone formation and consolidation and implants may then be placed.

3) Osteotome Technique with Grafting and Delayed Implant Placement

When the ridge bone height is less than 5 mm and implants are to be inserted in a later stage this technique is used. Osteotomy is carried out by using a trephine bur (with internal diameter depending on diameter of implant), up to the sinus floor. Then the bone cylinder taken with a trephine bur is pushed using an osteotome with a concave point, by use of the surgical mallet with small strikes. The sinus membrane will be lifted by the bone cylinder. Autogenous bone and/or bone substitutes are added until the drilled site in the alveolus is filled with bone. The osteotomes must not penetrate the sinus space during this procedure [1].

The bone cylinders remain adherent to the Schneiderian membrane and remain vital and supply osteoprogenitor cells and blood to the grafted site. Implants are inserted 6-8 months later.

4) Osteotome Technique with Immediate Insertion of Implants without Grafting

The main goal of this procedure is to take care of all the bone harvested from the walls of the surgical procedure and to push it apically to elevate the sinus floor. On radiographs the peak of the residual crestal bone ridge is measured. throughout the procedure the tip of the instruments mustn't penetrate within the sinus cavity, and therefore the Schneiderian membrane mustn't be touched. Graft material then must be used to elevate the sinus floor and then the sinus membrane. Then adaption of appropriate shape and size of the implants [1].

G. Lacerations of the Sinus Membrane

Lacerations of the Sinus Membrane Can Be Caused:

- When there's inadequate use of osteotomes.
- When there's a skinny membrane.
- When there's an outsized volume of graft material is chop-chop inserted.
- Presence of septa.
- The use of burs within two millimeters from the sinus floor, which can need bigger force for lifting the compact bone with osteotomes [24].
- Preparation of implant sites to a depth of within 2 millimeters from extent of the apices of the adjacent teeth [1].
- Lifting of membrane more than five millimeters [25].

Later on, the bounds of the first sinus floor become harder and a new sinus floor may be seen on radiographs in higher position [1].

Additionally, once the osteotome technique for augmenting the sinus planned, the elevation of the mucoperiosteal flap is restricted to the crestal area, so limiting decrease or distraction to blood flow of lateral wall of the sinus. Complications of sinus augmentation occur like: intraoperative hemorrhage, membrane perforation and surgical sinus pathologies, are delineated in a very restricted range of clinical studies [26].

H. Open Sinus Augmentation

When there's an absence of sufficient alveolar bone, insertion of dental implants within the posterior upper jawbone become difficult, therefore; we want to enhance the sinus at the same time with implant insertion or 6-12 months after augmentation. Here we tend to consider the open sinus lifting procedure; it has disadvantages when compared with different strategies (i.e., closed method) of augmenting the sinus [27].

While this open technique has the advantage of having the ability to enhance sites to permit for insertion of multiple implants, it has some consequences like magnified post-operative morbidity moreover as swelling and hematoma formation. Different limitations of the lateral sinus lifting approach represent restricted visibility and access to the sinus, moreover as potential perforation of the Schneiderian membrane [28].

1) Procedures

Depending on what density of bone within the alveolar ridge one of these 2 procedures is performed:

a) Sinus augmentation graft and placement of implants at the same time (this is typically done when we have 4-5 millimeters of bone to stabilize the fixture) [28].
b) Sinus augmentation with bone graft and waiting 6- 12 months before inserting of dental implants (this is typically done when there are less than 4-5 millimeters of bone and initial stability cannot be obtained) [23].

I. Grafting Materials

PRF (Platelet rich fibrin) in sinus lifting has been stated to be used by adding to bone substitute materials [29]. A greater proportion of new bone formation was established when the Bovine mineral and PRF mixtures were used, (compared to the Bovine mineral individuals without PRF).

Autologous bone graft: Autologous bone is reflected as the golden typical material. It has both properties of osteo-induction and osteo-conduction and affords osteoprogenitor cells which has osteogenic prospective and progresses osteoblasts that create organic and inorganic medium. osteoinductive process affected by Growth factors and proteins that improve the curing of autogenous bone graft. Autologous bone using has 2 important benefits:

a) No immunogenic response is initiated.
b) The bone fills with growth factors that prompt bone remodeling. Harvesting of Bone can be from different portions of the body's bone (ex. the iliac bone crest, mandibular ramus bone, chin, tibia and calvarium [23].

Xenografts: Xenografts are demarcated as bone taken from a bone tissue from a different species. All organic material is eradicated so the result is just inorganic and de-proteineized cancellous bone to make sure that the immune response cannot occur. The resulting bone has the similar construction of the spongy bone of human. A xenograft material submits to slowly a physiological remodeling or resorption .an example of xenograft is "Bio-Oss" that is a de-proteinzed bovine bone, which has: osteoconductive properties and biocompatibility. Bio-Oss is frequently used in sinus lifting [23].

Bovine mineral has been predictable as a good bone substitute in regenerative procedures [30]; it is used alone or in combination with autografts or alloplasts [31]. It has been presented to be biocompatible, osteoconductive, and gradually resorbable. However, sinus augmentations with it sometimes fail, and the clinician then faces a situation where regenerated bone is not sufficiently nourished in the augmented area; therefore, a new solution should be required for qualitative and quantitative improvement of sinus grafting [32].

Allografts: define as bone tissue that originates from other individual with identical species and are manipulated with several methods, e.g. freezing, drying, or subjected to radiation etc [23].

Alloplastics: defined as artificial bone graft this is alienated into different groups according to its morphological and density properties. The structure decides by what method the material is acting. For examples of alloplastic materials are: beta-tricalcium phosphate, bioactive glass and calcium sulfate [23].

Growth factors: Tissue-engineered materials have also been used for sinus augmentation bone morphogenetic protein (BMP). Bone morphogenetic protein 2 is one that has been sequenced and recreated as a recombinant human protein growth factors can be added to all grafting materials [33].

Oxidized regenerated cellulose (Surgicel): Is a sterile completely resorbable hemostatic material [34]. It is momentarily material that can be mange perforations of the Schneiderian membrane. Reference [35] used it as report grafting material.

J. Complications

- Intraoperative complications:
  a) Damage of the artery.
  b) Perforations of the sinus membrane.

Their manifestation is conversely relational to the surgeon's skillfulness and has no impact on implant survival if they are suitably managed [36].

- Postoperative complications:

Infections that take place as chronic or acute sinusitis. Their incidence about (3-5%). They can consequence from an insufficient management of peri-operative problems or from improper assessment of the sinus pathology before operation [36].

K. Management of Perforation

Sinus lifting techniques sensitive and technically difficult. The Schneiderian membrane is incredibly thin and liable to perforation. Therefore care ought to be taken to prevention of perforation of the membrane.

Perforations of the sinus membrane smaller than five millimeters; will sometimes be closed by applying a suture, covering it with a membrane, or using tissue sealer with no further measures [36].

Larger perforations need request different technique. Varied techniques are instructed for this case, like use of tissue sealer, suturing the perforation, and covering it with an acceptable membrane. Some researchers advocate terminating the technique and suspending it 6 - 9 months that permitting the sinus membrane to heal [36].

III. Conclusion

Sinus lifting for increasing bone mass for placement of dental implant within upper jawbone has been unquestionable to be harmless and predictable. The adjustments of sinus morphology by sinus lifting don't threaten sinus except if there's sinus pathology. Sinus lifting failure is usually evaded by careful clinical examination and appropriate imaging as well as careful surgical procedure, to improve the prospected

result.

Sinus pathology is contraindication to sinus lifting unless treatment of the lesion first because it can lead to acute or chronic sinusitis.

Complete and virtual contraindications for the sinus lifting procedure take under consideration of general expressions of pathophysiology. The skilled surgeon can come with deferent treatment options so can decrease general operative risk and can manage any problems.

CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

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