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"AN INSIGHT INTO SINUS LIFT PROCEDURES" Unveiling sinus lift procedures

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ABSTRACT

A maxillary sinus lift procedure is necessary in posterior maxilla when there is inadequate amount of bone to support a dental implant, and one needs to be implanted. Several sinus augmentation techniques have been utilized with remarkable rates of success in order to enhance these areas for the purpose of implant placement. Familiarizing the anatomy of the maxillary sinus not only assists in effective treatment planning, but also enables us to prevent potential issues that may occur during sinus augmentation procedures. Both closed and open sinus lifting procedures are effective methods for augmenting bone volume necessary for optimal implant placement. This review provides an explanation of the fundamental methods, specifically direct and indirect sinus lift procedures, employed for the purpose of maxillary sinus elevation and augmentation.

Key words: maxillary sinus, sinus membrane, sinus lift

INTRODUCTION

Of all the paranasal sinuses, the maxillary sinus is the largest. It is possible to see two distinct types of bone resorption when maxillary posterior teeth are removed. Centripetal resorption represents the primary manifestation, which arises as an inherent outcome of bone remodeling subsequent to

tooth loss. Pneumatization towards the alveolar crest is the second type that happens in the sinus cavity. Both forms of bone resorption frequently result in decreased bone accessible for placing an implant, hence facilitating the need of a regenerative procedure referred to as maxillary sinus lift surgery. Sinus lift procedures are well acknowledged as a reliable therapeutic option that carries a decreased probability of unfavorable consequences. The primary goal of this treatment is to produce an adequate amount of bone in both width and height in order to strategically position dental implants. [1]

The surgical procedure known as maxillary sinus floor augmentation (MSFA) requires the elevation of a Schneiderian membrane to augment the remaining height of bone in the maxillary posterior area. This enhances the quantity of bone accessible for placing dental implants in this region. Elevation can be attained using either the transcrestal or lateral methods.[2]

Sinus lift surgery

Sinus floor elevation, previously referred to as the sinus lift procedure, involves the interior augmentation of the maxillary sinus. The lateral maxilla's vertical bone regeneration is the main goal of this surgical operation hence facilitating the dental implant placement. It was invented and first presented by Tatum during the 1976 implant symposium held in Birmingham, Alabama.

Sinus lift is often performed by creating a door with a top hinge located in lateral maxillary sinus. The door undergoes inward and upward luxation, along with lifting of the Schneiderian membrane, that leads to horizontal displacement and the subsequent creation of an entirely new sinus bottom. Graft material was inserted into the sinus mucosa by lifting the door and filling the space beneath it.

Indications

1. The presence of inadequate vertical bone height for the purpose of placing an implant, resulting from factors such as alveolar ridge resorption, sinus pneumatization, or a combination of both.
2. Repair of an oroantral fistula
3. Reconstruction of the alveolar cleft
4. Le Fort I with the placement of grafts
5. Reconstruction of craniofacial prostheses for cancer patients. [3]

Contraindications

1. Elevated levels of head and neck radiation
2. Sepsis
3. Sophisticated medical conditions
4. Unregulated systemic disruptions
5. Overindulgence in smoking, alcohol, or substance abuse
6. Psychological disorders. [4]

General considerations

Sinus lifting is commonly advised in cases when the residual bone height is ≤10 mm, and there exists a gap of 1 to 2 mm of bone between the top of the implant and the floor of the sinus. The sinus lifting treatment can be performed using two primary techniques: the lateral window and the trans-alveolar (crestal osteotome). If the bone height exceeds 5 mm, the preferred therapy is the crestal osteotome. Nevertheless, in cases when the height of the ridge is significantly diminished, it is recommended to employ a lateral window. This method can assist in attaining a height of up to 9 mm, which is sufficient to offset bone deficiency. [5]

Surgical technique

At present, the literature presents two primary methodologies for the maxillary sinus floor elevation procedure. The initial method, known as lateral antrostomy, is a well-established and often employed technique that was initially documented by Tatum. In recent times, Summers has promoted an alternative method with the use of an osteotome known as the crestal approach. The crestal approach is widely regarded as a more conservative technique for elevating the sinus floor. [5]

The earliest lateral window method was introduced by Tatum H in 1975. The procedure is done by making an opening on the lateral wall of sinus, and then elevating the Schneiderian membrane with caution by establishing a trapdoor osteotomy to ensure the correct insertion of the implant(s)

with appropriate lengths. When the bone height is reduced, the lateral approach technique is very helpful since it enhances vertical height of the bone that exceeds 9 mm.

A fundamental constraint associated with the lateral antrostomy procedure is the requirement to raise a significant flap in order to obtain surgical entry. In 1994, Summers introduced a conservative crestal technique that involves the utilization of an osteotome to raise the floor of the maxillary sinuses. The procedure commences by making an incision at the crestal region. Elevation of a full thickness flaps exposes the alveolar ridge. After that, an osteotome is created using a mallet or drill. [6]

TECHNIQUES OF MAXILLARY SINUS LIFT

Different techniques for maxillary sinus lift are as follows:

1. **Summers osteotome technique:** Summers devised a method of osteotomy preparation that does not involve the removal of the bone. The goal of this procedure is to create an osteotomy that is precisely formed while preserving as much of the existing maxillary bone as feasible. This is achieved by gently moving the bone aside. Unlike drilling, the osteotome approach enhances the structure of the maxilla by expanding the ridge during the insertion of the instruments. The procedure referred to as a ridge expansion osteotomy (REO) differs from a drilling site in that it does not alter the width of the bucco-palatal bone. [7]

2. **Piezoelectric bony window osteotomy and sinus membrane elevation:** The lateral window osteotomy and osteotome sinus elevation techniques are frequently employed procedures that encounter the challenge of causing a sinus membrane puncture. This may happen via the use of burs during osteotomy or through the use of manual elevators during membrane separation. In the event of perforation, the bone grafts may reach the ectopic site, resulting in the formation of an oro-antral fistula. The piezoelectric bone window osteotomy and elevation of the sinus membrane (PBWO and PSME) procedure was introduced by Vercellotti et colleagues in 2001 as a means to simplify the sinus augmentation surgery. The present methodology employs a meticulously designed

apparatus known as the Mectron Piezosurgery system for the purpose of executing the osteotomy procedure. [8]

3. **Subantroscopic laterobasal sinus floor (salsa) technique:** Engelke and Deckwer introduced a novel endoscopically regulated method for augmenting the sinus floor. The procedure entails the transalveolar mobilization of the sinus membrane, which is regulated by sinoscopy, transalveolar augmentation, and concurrent implant placement. This approach has been recommended for alveolar regions that have had moderate reduction. The modified endoscopic technique known as the laterobasal tunnel technique was developed by Engelke et al. This technique enables the augmentation of multiple maxillary areas by a single small laterobasal trepanation. This method enables the complete enclosing of the sinus membrane from the premolar to the second molar site, facilitating significant augmentations for both primary and secondary implantation. The endoscope is inserted into the maxillary sinus by a puncture of the canine fossa in both procedures.[9]

4. **Sinus/alveolar crest tenting (sact) technique:** In the 1980s, a method was devised that employed osteotomes to elevate the sinus membrane, eliminating the requirement for any form of graft material. In the study conducted by Summers, a trephine was employed to excise the osteotomy site. Subsequently, osteotomes were utilized to insert bone beneath the sinus membrane, ensuring that an optimal amount of 7 mm of bone was available. This technique, known as localized management of the sinus floor (LMSF), aimed to elevate the sinus floor while simultaneously positioning a dental implant. The current SACT technique is derived from the principles of the LMSF technique. In contrast, the SACT technique allows for the placement of implants with a bone thickness of 1 to 3 mm, without the need for graft material or membranes to cover the surgical site. [10]

5. **Boyne's distraction osteogenesis technique:** Distraction osteogenesis (DO) refers to a biomechanical phenomenon in which bone tissue is formed through the application of distraction stresses between bone segments. These forces influence the biological potential of the bone, resulting in the production of a callus with specific dimensions in terms of length and height. Distraction osteogenesis is initiated by performing a corticotomy or sub-

periosteal osteotomy, and subsequently, the distractor is fixed to the segments, resulting in their gradual elongation. [11]

6. **Sinus elevation with blood clot formation:** Although, the placing of bone grafts within the maxillary sinus might lead to the growth of new bone it is important to note that such placement may not necessarily be a necessary condition for bone creation. The process of sinus membrane elevation, subsequent void formation, and subsequent blood clot formation can potentially develop a new bone according to the principles of directed tissue regeneration. [12]

7. **Palatal piezosurgical window osteotomy:** Piezoelectric osteotomies have introduced novel concepts for bone cutting and surgical techniques, leading to their development and eventual success. This technical paper presents a novel palatal technique for elevating the maxillary sinus through the utilization of Piezosurgery. The inclusion criteria are patients with no sinus disease and exhibit a reduced alveolar crest height where the implant is planned. Remaining alveolar bone height must be below 5 mm, as determined by preoperative radiography. The alveolar crest must have a minimum transversal width of 7 mm, which is ascertained using a caliper during a basic assessment. [13]

8. **Reamer-mediated transalveolar sinus floor elevation without using osteotome:** Controlling the osteotome tapping force is challenging when utilizing these techniques to achieve successful membrane lifting without causing membrane perforation, which can be uncomfortable for the patient. This procedure involves minimally invasive transalveolar sinus floor elevation using a specifically made reamer featuring with 85-degree cutting angle (CA) and a single cutting edge (CE). Because of the absence of an osteotome and mallet in this procedure, it is possible that patients may have reduced tactile sensitivity and decreased discomfort compared to the usual osteotome technique. [14]

MINIMALLY INVASIVE TECHNIQUES

1. **The osteotome/trephine procedure:** The technology was first presented in 1999 and subsequently improved by the simultaneous placement of implants. A 3 mm diameter trephine bur is used to prepare the implant site. The bur is positioned 1-2 mm above the sinus floor. Following this, the bone cylinder is then moved towards the apex to a depth that is <1 mm the depth attained using the bur. The accomplishment of this task is facilitated by utilizing an osteotome that possesses an equivalent diameter to that of the trephine bur. The final implant site preparation involves the utilization of osteotomes with progressively larger sizes, consistently inserted to a consistent depth. The insertion of the implants occurs at a rate of 30 revolutions per minute (rpm), resulting in the deliberate lateral displacement of the bone cylinder within the cavity formed by the sinus membrane's motion. [15]

2. **Antral membrane balloon:** Soltan et al. (2012) provided a description of the methodology employed for the ballooning of the antral membrane. This process involves the sinus membrane elevation by the use of an inflating balloon. The primary objective of the Zimmer sinus lift balloon is to provide gradual and consistent lifting of the membrane of the sinus. This process lowers the chance of a sinus membrane perforation. The metallic shaft consists of a tip that is connected to a latex balloon, which has around 5 cm of inflation capacity. The lateral window technique employs a balloon design that is inclined, whereas the crestal approach utilizes a balloon design that is straight. [16]

3. **Minimally invasive transalveolar sinus approach (MITSA):** It was introduced by Kher et al. in 2014. The hydraulic sinus membrane-raising process involves the utilization of calcium phosphosilicate putty. The drilling procedure is performed One millimeter under the sinus floor, the osteotome location is completed till the final drill. A 3 mm concave osteotome is employed for the purpose of in-fracturing the sinus floor. The Novabone gun cannula is designed to fit securely into a prepared osteotomy. The consistency of the material allows for a gentle elevation of the membrane. Subsequently, the implant is inserted. [17]

4. **Transrectal-guided sinus lift procedure:** Pozzi and Moy introduced a minimally invasive transrectal-guided sinus lift procedure. The present methodology involves the utilization of computer-assisted design and a guided surgical approach for the purpose of elevating the maxillary

sinus. The minimally invasive aspect of this surgical method is achieved through the utilization of computer-aided manufacturing/design techniques to construct a surgical template, employing expander-condensing osteotomes. [18]

RECENT ADVANCES IN SINUS LIFT SURGERY

1. Smart lift technique: This procedure was introduced by Franceschetti et al. The implementation of the Smart Lift technique, combined with graft biomaterials, resulted in a uniform displacement of the sinus floor towards the apex and a low occurrence of postoperative morbidity. The implant site's vertical growth is achieved by utilizing the Smart Lift technique, which involves relocating the compressed trephined bone core into the sinus.[19]

2. Platelet-rich plasma (PRP) in sinus lifting: PRP is a form of autologous fibrin adhesive that may be easily generated from whole blood by centrifugation, leading to a significant concentration of platelets. Furthermore, it is worth noting that PRP demonstrates a significant presence of mitogenic and angiogenic growth factors, which are recognized for their pivotal involvement in the bone healing mechanism. The factors encompassed in this category consist of platelet-derived growth factor (PDGF), transforming growth factor (TGF), & insulin-like growth factor. In contemporary times, PRP has been utilized for the purpose of elevating sinus floor. [20]

3. Augmentation of maxillary sinus with tissue-engineered bone: The utilization of cultivated periosteal cells for tissue-engineered bone and cartilage regeneration was initially documented by Rich et al in 1994. Breitbart et al. cultivated cell cultures in osteogenic environments using periosteal tissue obtained from an adult New Zealand white rabbit's proximal tibia. In a rabbit model, critical-sized calvarial injuries were successfully repaired achieved through the utilization of a polyglycolic acid scaffold. [21]

4. Platelet-rich fibrin, endoscope, simultaneous placement of implant, and sinus floor elevation (PESS): Research studies examining the concentration of growth factors and the kinetics of their release have indicated that platelet-rich fibrin (PRF) exhibits superiority compared to alternative platelet concentrates. PRF is considered a therapeutically beneficial substitute for conventional PRP owing to the incorporation of fibrin, a notable auxiliary molecule that serves as

an effective carrier in tissue regeneration. The implementation of the PESS procedure, which combines PRF endoscope, simultaneous placement of implant, and elevation of sinus floor, has considerable potential as a treatment approach for individuals with less than 4 mm of remaining alveolar crest height. By combining PRF with endoscopic-guided trans-crestal elevation to the sinus floor and implanting it at the same time, it is feasible to finish fitting the final prosthesis in a considerably shorter duration of 3 months, in contrast to the usual 12-month timeframe linked to conventional treatment approaches. [22]

Conclusion

Oral rehabilitation using osseointegrated implants is highly successful and reliable in patients with normal bone density and volume, as it ensures sufficient stability of implants with conventional dimensions. Insufficient bone quantity and quality have long been seen as definite reasons to avoid implant-supported rehabilitation. Augmenting the maxillary sinus floor is a frequent procedure used to create ideal conditions for implant insertion. An implant used for maxillary sinus augmentation/elevation is a surgery that offers significant benefits to patients when approached with enough preparation, education, and expertise. It has a high likelihood of producing predictable results.

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