Review Article

Approach to Maxillary Sinus and Success of Dental Implants

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Abstract: Dental implants for edentulous areas of the mouth have become the standard of care, and the number of dentists placing them is increasing. One challenging location for these implants, however, is the posterior maxilla. Even with adequate crestal bone width, implant placement may be limited by a lack of vertical bone height. In the past, surgical techniques to overcome this obstacle were daunting, and the thought of approximating the maxillary sinus was out of the question for more conservative clinicians. With the development of new innovative surgical instrumentation and careful case selection, more dentists are now using new protocols and performing at least some of these implant-associated surgeries on a regular basis.

Keywords: Hydropneumatic; Maxillary; Osteotomy; Sinus; Zygoma.

INTRODUCTION

The maxillary sinus augmentation, first described by Tatum and subsequently modified by Boyne and James, is frequently indicated in patients with severe alveolar bone resorption or excess pneumatization of the maxillary sinus, resulting in a bone deficiency in the posterior maxilla. The procedure involves elevating the Schneiderian membrane through a lateral window to make sufficient space for bone augmentation in preparation for subsequent dental implant placement. Summers introduced a surgical approach, which used a series of osteotomes that come in different diameters with concave tips and sharp edges to collect and condense bone in through the osteotome.

Anatomy of the Maxillary Sinus: The maxillary sinus is a pyramidal structure in which the base is oriented toward the nasal wall and lateral apex extends into either the zygomatic process of the maxillary bone or the zygoma.[1,2] Anteriorly, the sinus extends to the canine and premolar area; the most inferior point of the floor extends to the first molar region. The roof is formed by the orbital floor and the infraorbital nerve that exits through the infraorbital foramen.[3] Behind the posterior wall is the pterygo-maxillary fossa, which contains important structures, such as sphenopalatine ganglion, internal maxillary artery and the greater palatine nerve. Pneumatization leaves a thin bone in both the occlusal and lateral walls of the posterior maxilla.

The overall dimensions of the maxillary sinus are 33 mm in height, 23 mm in width, and 34 mm in the antero-posteriorly; the average volume is 15 mL.[4] The vascular supply of the maxillary sinus mainly comes from the maxillary artery, including the posterior superior alveolar and the infraorbital arteries.[5] Nerve supply to the sinus is derived from the second division of the trigeminal nerve (maxillary nerve V2) through the superior alveolar nerve. Venous drainage runs into the facial vein, posteriorly into the maxillary vein, and jugular vein. The lymphatic drainage occurs through the infra-orbital foramen and the ostium.

Sinus Elevation: The elevation of the sinus floor is an internal augmentation of the maxillary sinus, intended to increase the vertical bony dimension of the lateral maxilla to allow placement of dental implants in sites with insufficient alveolar bone height.[6] The procedure was introduced by Tatum at an Alabama dental implant conference in 1976 and was subsequently described by Boyne & James in 1980.[7,8] The classic sinus lift procedure consists of the preparation of a window in the maxillary sinus wall. The space underneath the membrane is filled with graft materials accordingly. If bone height is sufficient to achieve primary stability (approximately 4 mm), implants can be inserted simultaneously. However, if the grafted bone has to remodel, implants should be inserted in a subsequent procedure. There are 2 main approaches for maxillary sinus floor elevation: the lateral antrostomy approach and the crestal approach.

Lateral Antrostomy Technique: This starts with a crestal incision in the alveolar ridge.

A full-thickness flap is then raised to gain access to the lateral sinus wall. With a round bur a U-shaped trapdoor is made on the lateral wall of the maxilla. A CT scan verifies that the height of the trapdoor does not exceed the width of the sinus. A curette is used to lift the sinus membrane from the bony floor in 3 directions (anteriorly, posteriorly, and medially) gently; lifting proceeds from the apico-distal to the corono-mesial direction in order to release the tension on the membrane. The space is then filled with graft. Implants are placed either immediately (1-stage) or after a delayed period of up to 12 months (2-stage) if graft maturation is necessary. The implant site should not be overfilled, as that may lead to membrane necrosis. The single stage procedure is less time consuming; however, it is more technique sensitive. The procedure's success relies on the amount of residual bone. One of the disadvantages of the 1-stage technique is that it requires a large flap for surgical access.

Crestal Approach Technique: This technique begins with an incision in the alveolar crest. A full-thickness flap is then raised to expose the bone. Then, an osteotomy is performed, starting with the smallest size osteotome, which is tapped in place in the bone with a mallet. Gradually increasing sizes of osteotomes are then used to expand the alveolus and compress the bone. After the largest osteotome has been used, bone grafting material is added to the osteotomy site so that it presses on the sinus membrane. Elevation of the membrane occurs due to this pressure. Additional grafting material may be used to achieve the desired elevation. An implant slightly larger in size than the osteotome is inserted in the site. The crestal approach technique is a less invasive procedure, improves the density of the maxillary bone, and has the potential to allow the use of less autogenous grafting material. The disadvantage is an increased risk of misaligning the long axis of the osteotomy done during the sequential osteotomy.

Various techniques for sinus augmentation have been introduced over the years. The original techniques involved rotary appliances, such as surgical handpieces or high-speed handpieces. The devices modified for sinus lifting by Wood & Moore, who reported their hinge osteotomy technique in 1988. In 1997, Smiler reviewed multiple technique variations for sinus elevation. Then in 2001, Vercellotti et al introduced the piezoelectric technique (already used in Europe) to the United States. Lozada et al described the Dentium Advanced Sinus Kit technique (Dentium) in 2011.[9]

The piezoelectric osteotomy procedure involves cutting a window in the alveolar bone. This can be done with great simplicity and precision—avoiding the risk of perforating the membrane—because of the shape of the bone scalpels, which work with ultrasonic modulating vibrations. The piezoelectric device has the ability to automatically cease surgical action when the scalpel comes into contact with non-mineralized tissue. Separation of the membrane is achieved by the ultrasonic vibrations of the piezoelectric device and by the hydropneumatic pressure of the physiologic solution used in a piezoelectric cavitation. The hydrodynamic pressure applied by irrigating solution in PS helps in sinus membrane dissection. Using piezoelectric ultrasonic vibration of 25-30 kHz, the device cuts mineralized structures without cutting the soft tissue. The cavitation effect induces a hydropneumatic pressure of saline that contributes to the atraumatic elevation of the sinus membrane. When the osteotomy of the maxillary sinus is performed with piezoelectric ultrasonic vibration the bone loss is usually lower. Other advances include specialized safe-cutting drills and diamonds, hydraulic pressure (aqua-toca), and balloon elevation techniques.

Hyradulic Pressure Technique (Aqua-Toca): There is low risk of perforation using hydraulic pressure when lifting membrane. It makes the membrane lifted as the dome shaped always. It uses the aqua lift system in which saline is discharged into the sinus and the Schnederian membrane is lifted. There are five holes (four on the side and one on the top) which help the sinus lift in a dome shape.

Balloon Elevation Technique: In this method, a small hole is made in the bone and a balloon filled with liquid is used to lift the membrane and create the space. The space is then filled with the patient's own bone or a bone substitute and allowed to heal before placement of dental implant.

CONCLUSION: Knowledge and awareness of the existing literature and extensive training are essential for dentist who aim to perform sinus augmentation procedures. Careful planning will decrease the incidence of complications. Several factors must be considered including the age of the patient as well as the patient's oral hygiene habits and history of smoking. Future research should emphasize on the following areas: volume of the sinus and its effect on the success of the grafting procedure and the implant; the use of mesenchymal stem cells for sinus augmentation; the effect of systemic diseases on the success of the augmentation procedure, grafting, and implants; and the effect of smoking on the successand survival rates of implants placed insinus-grafted sites.

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