

Maxillary Sinus Lifting: Review of the Two Main Approaches



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Submission: June 19, 2017; **Published:** July 07, 2017

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Abstract

There are different techniques for sinus lifting and augmentation; the factors that contribute to the survival rate of sinus augmentation and dental implant placement are still the subject of discussion. Sinus floor elevation is commonly used in cases where alveolar bone resorption has led to insufficient bone height for the placement of dental implants.

Keywords: Maxillary Sinus Elevation; Augmentation; Dental Implants

Introduction

Implant dentistry has become an excellent treatment modality since its inception into the modern era of dentistry. It not only allows for a conservative and esthetic alternative to treating partial edentulism, but also provides a stable foundation for treating complete edentulism. Dental implants are a viable treatment option when there is sufficient quantity and quality of bone. However, when patients present with deficient alveolar ridges, it could jeopardize the application of implant dentistry [1].

This problem is especially magnified in the posterior maxilla where ridge resorption and sinus pneumatization, compounded with a poor quality of bone, are often encountered. The procedure of choice to restore this anatomic deficiency is maxillary sinus floor elevation (sinus lift). When patients present with deficient alveolar ridges, it could jeopardize the application of implant dentistry. This problem is especially magnified in the posterior maxilla where ridge resorption and sinus pneumatization, compounded with a poor quality of bone, are often encountered. The procedure of choice to restore this anatomic deficiency is maxillary sinus floor elevation (sinus lift) [1].

The height of the alveolar ridge in the maxilla is the resultant of masticatory forces transferred by the periodontal ligament system to the bone and pneumatisation of maxillary sinuses beginning with eruption of the third molars [2]. Bone atrophy in the maxilla is a physiological process, which accelerates in case of tooth extractions [3]. In females higher post-extraction bone resorption is observed compared to males [4], which may

be related to density of the bone tissue and hormonal balance of the body. The research proves that more severe atrophy may be expected when molars are extracted rather than premolars [5] and when a greater number of adjacent teeth are extracted [6]. Prolonged healing time resulting from numerous and traumatic extractions also promotes more severe atrophy of bone tissue.

Unskilful tooth extraction may be associated with the damage of the thin lamina dividing the maxillary sinus and the alveolus as well as rupture of the sinus-lining membrane, which hence exacerbates the extraction-related, physiological atrophy of the ridge hard tissue [6]. Insufficient vertical dimension of the alveolar ridge is a relative contraindication for implantation. Owing to techniques of alveolar ridge reconstruction introduced in surgery in 1970s the optimal size of the ridge bone may be restored [3,7] and implantation may be successfully performed [8].

Anatomy of the Maxillary Sinus

The maxillary sinus is a pyramid-shaped cavity with its base adjacent to the nasal wall and apex pointing to the zygoma. The size of the sinus is insignificant until the eruption of permanent dentition. The average dimensions of the adult sinus are 2.5 to 3.5 cm wide, 3.6 to 4.5 cm in height and 3.8 to 4.5 cm deep [9]. It has an estimated volume of approximately 12 to 15 cm³ [10]. Anteriorly, it extends to the canine and premolar area. The sinus floor usually has its most inferior point near the first molar region.

The size of the sinus will increase with age if the area is edentulous. The extent of pneumatization varies from person to person and from side to side [9]. Nonetheless, this process often leaves the bony lateral and occlusal alveolus paper thin in the posterior maxilla. The maxillary sinus bony cavity is lined with the sinus membrane, also known as the schneiderian membrane. This membrane consists of ciliated epithelium like the rest of the respiratory tract. It is continuous with, and connects to, the nasal epithelium through the ostium in the middle meatus. The membrane has a thickness of approximately 0.8 mm.

Antral mucosa is thinner and less vascular than nasal mucosa [9]. The blood supply to the maxillary sinus is principally derived from the posterior superior alveolar artery and the infraorbital artery, both being branches of the maxillary artery. There are significant anastomoses between these two arteries in the lateral antral wall. The greater palatine artery also supplies the inferior portion of the sinus [11]. However, because the blood supplies to the maxillary sinus are from terminal branches of peripheral vessels, significant hemorrhage during the sinus lift procedure is rare. Nerve supply to the sinus is derived from the superior alveolar branch of the maxillary (V2) division of the trigeminal nerve.

Methodology

Lateral Sinus Lift is usually carried out under general or local anesthesia, or under analgesia. After lifting the mucoperiosteum from the front wall of the maxilla, a round bur is used to create a window in the thin bone demarcating the maxillary sinus. Antral mucosa must remain intact. Then the mucosa is lifted away from the bone using a special raspatorium to the extent of the alveolar recession and dislocates the same cranially. A space will be created at the base of the maxillary sinus that is filled with an appropriate augmentation material [12].

Currently, two main approaches to the maxillary sinus floor elevation procedure are found in the literature. The first approach, lateral antrostomy, is the classic and the more commonly performed technique originally described by Tatum. More recently, Summers advocated a second approach: the crestal approach, using osteotomes [13]. The crestal approach is considered to be a more conservative method for sinus floor elevation. Lateral antrostomy is started with a crestal incision made on the alveolar ridge. Sometimes, this incision is made moderately palatal to the crest to preserve a wider band of keratinized attached gingival for a more solid wound closure and to avoid wound dehiscence.

A full-thickness flap is then raised to allow access to the lateral antral wall. Once the flap has been raised to a desired level, antrostomy is performed with a round bur to create a U-shaped trapdoor on the lateral buttress of the maxilla. The height of this trapdoor should not exceed the width of the sinus to allow for a final horizontal position of the new floor. The sinus membrane is then gently lifted from the bony floor by means of an antral

curette. Marx and Garg [14] suggested using a cottonoid soaked with a carpule of 2% lidocaine with 1:100,000 epinephrine and left in the space created for 5 minutes so as to limit bleeding and allow for better visualization for further dissection.

It is important to free up the sinus membrane in all directions (anteriorly, posteriorly and medially) before attempting to intrude the trapdoor medially. A space is created after the sinus membrane has been elevated by the intruded trapdoor. This space is then grafted with different materials to provide the platform for implant placement. Numerous research projects have been published to evaluate the prognosis of implants under different grafting materials [15,16]. Autogenous bone remains the gold standard in bone grafting [17]. Iliac crest, chin, anterior ramus, and tuberosity have all been mentioned as common autogenous donor sites in maxillary sinus lift. Hydroxyapatite mixed with autogenous bone or used alone are also viable alternatives [18].

Care should be taken not to overfill the recipient site, because it will cause membrane necrosis. Implants are placed either simultaneously with the graft (one-stage lateral antrostomy) or after a delayed period of up to 12 months to allow for graft maturation (two-stage lateral antrostomy). The initial bone thickness at the alveolar ridge seems to be a reliable indicator in deciding between these two methods. If the bone thickness is 4 mm or less, initial implant stability would be jeopardized. Therefore, a two-stage lateral antrostomy should be carried out. The reverse holds true for a one-stage procedure [19]. A one-stage procedure is less time-consuming for both the clinician and the patient. However, it is more technique-sensitive and its success relies heavily on the amount of residual bone.

Intraoperative and Postoperative Bleeding

Significant hemorrhage during the sinus lift procedure is rare because the blood vessels that supply it are the terminal branches of peripheral vessels [20]. However, branches of the posterior superior alveolar artery, a branch of the maxillary artery, may travel through the area of sinus window preparation [20]. Thus, perforation of these blood vessels can occur. Intraoperative bleeding can be controlled by placement of the bone graft, which exerts pressure on the wound. However, significant bleeding may be challenging to manage as the bone graft particles may wash out. If a vessel in the lateral wall of bone is noted, a crush injury to the vessel can stop the bleeding [21]. Postoperative bleeding may sometimes occur in the form of a nose bleed. Patients should be advised of this possibility and be instructed not to blow their nose for at least 5 days after the operation. Postoperative bleeding from the surgical site is rare and can be avoided through adequate primary closure and thorough suturing [21].

Perforation of the Schneiderian Membrane

Perforations of the Schneiderian membrane are relatively common. Cone-beam CT scans should be obtained in advance to assess anatomical variations, such as a very thin membrane

or challenging sinus anatomy (i.e., deep, narrow sinuses or undulating floors) that may increase the risk of perforation. The membrane may be perforated during osteotomy preparation or membrane elevation. Perforation during preparation may be minimized by exerting care when using a high-speed bur or by using a piezoelectric unit [21].

If perforation does occur, it is important to attempt to elevate the membrane around the perforation. This may require expansion of the osteotomy site. In case of a large perforation, this may not be possible. Small perforations can be repaired by placing a resorbable collagen membrane over the perforated area after it has been elevated and before the addition of bone graft. Larger perforations are more common in areas of challenging anatomy and are more difficult to deal with. They are usually repaired using larger resorbable membranes fixed to the superior aspect of the osteotomy window with bone tacks before bone augmentation [21].

Postoperative Swelling and Hematoma

Following lateral window sinus augmentation, significant swelling and hematoma formation in the cheek and under the eye commonly occur. To avoid significant swelling, a steroid may be used and an NSAID is highly recommended. Patients with such conditions should be carefully monitored [21].

Postoperative Infections

Postoperative infections after sinus elevation are relatively rare, occurring in approximately 2% of cases [22]. The use of appropriate antibiotics before and after the surgical procedure is standard and may reduce infection risk. Amoxicillin/clavulanic acid or a macrolide are appropriate choices. In the event of a postoperative infection, antibiotic choices provided in the clinical practice guidelines for adult sinusitis from the American Academy of Otolaryngology [23] should be used. If antibiotic therapy is not effective, incision and drainage should be performed. If the infection cannot be resolved, then a mucoperiosteal flap should be raised, the graft removed and the site thoroughly irrigated.

Drawback of Lateral Sinus Approach

One of the drawbacks of the lateral antrotomy is that it requires the raising of a large flap for surgical access. Summers proposed a conservative crestal approach using osteotomes for maxillary sinus floor elevation in 1994 [13]. This technique begins with a crestal incision. A full-thickness flap is raised to expose the alveolar ridge. An osteotome of the smallest size is then tapped into place by a mallet or drill into the bone. Preoperative bone height underneath the sinus is measured to determine the desired depth for osteotome extension. The goal is to extend the instruments just shy of the sinus membrane. Osteotomes of increasing sizes are introduced sequentially to expand the alveolus. With each insertion of a larger osteotome, bone is compressed, pushed laterally and apically summers stated that the very nature of this technique improves the bone

density of the posterior maxilla where type IV bone is normally found [24]. The disadvantage of the crestal approach is that the initial implant stability is unproven if the residual bone height is less than 6 mm.

The chances of achieving a sufficiently high elevation with the osteotome technique are limited [19]. With this approach, there could also be a higher chance of misaligning the long axis of the osteotome during the sequential osteotomy. Restoring edentulism with dental implants requires careful treatment planning. This is especially true with the posterior maxilla when pneumatized maxillary sinuses could limit the amount of alveolar bone for implant placement [25].

Contraindications

Disorders and conditions that contraindicate the sinus lift have not been fully defined yet. The following are the generally known and recognized rules:

- a) Purulent exudate in the maxillary sinus is the most frequently occurring contraindication of sinus lift. Empyema, whether a symptomatic or not, is an absolute, though temporary, contraindication.
- b) Situation after Caldwell-Luc operation usually makes the Sinus Lift highly difficult or impossible. Scar tissue cannot be treated as physiological mucosal lining.
- c) If the patient reports a history of acute sinusitis and the cause has not been eliminated, the augmentation may increase the proneness to further attacks of inflammation. The patient must be informed to this respect.
- d) Chronic sinusitis does not complicate the Sinus Lift. On the contrary hyperplastic antral mucosa is increased mechanical resistance, which facilitates the preparation.
- e) Mild osteoporosis is not considered to be contraindication, while moderate forms of this disease require prolongation of the healing period up to twelve months. Surgery is never performed in case of severe osteoporosis.
- f) Concurrent treatment with anti-aggregation drugs causes no life-threatening bleeding. Nevertheless it is recommended to discontinue such treatment subject to an agreement with the treating physician. Dose reduction is required in case of concurrent treatment with anticoagulants (the borderline level is INR 1.8). If not realistic, the patient should be transferred to low-molecular heparin.
- g) Inhalation or superficial application of corticosteroids has no influence on the effects of surgery, as the absorbed dose of the medication is low.
- h) Age itself is not a contraindication.
- i) Controlled diabetes mellitus is not considered to be a contraindication, independently of the type of treatment.
- j) Heavy smokers frequently have a thin mucous lining

of the maxillary sinus, which is highly prone to perforation during the surgery [12].

Conclusion

Maxillary sinus floor elevation offers one of the most common solutions for preprosthetic procedures problems. There are two main techniques, the classic lateral antrostomy and the more conservative crestal approach. Lateral approach allows for a greater amount of bone augmentation to the atrophic maxilla but requires a larger surgical access. The crestal approach is minimally invasive but permits only a limited amount of augmentation. Therefore, practitioners should select the adequate type of procedure needed and considering anatomical variations.

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DOI: 10.19080/GJO.2017.08.555745

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