

Treatment Options for the Atrophic Posterior Maxilla

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Abstract

Maxillary sinus augmentation has been shown to be a predictable surgical procedure used to enhance bone volume for the placement of dental implants in the atrophic posterior maxilla. Therefore, various techniques have been proposed in order to achieve the necessary bone dimension for the insertion of implants in previously compromised sites. Careful case and material selection corresponding to different indications can be beneficial to achieving predictable and consistent treatment outcomes in the posterior atrophic maxilla.

The purpose of this review was to discuss the indications, contraindications, limitations, and case selection criteria used to determine treatment options for the different techniques. It is necessary to define case selection criteria according to the remaining crestal bone and the anatomy of the sinus cavity.

Keywords: Maxillary sinus augmentation; dental implant; osteotome; lateral wall; bone graft

INTRODUCTION

Implant therapy for rehabilitation of edentulous posterior maxillary regions often presents a challenge due to inadequate alveolar ridge and poor quality of bone. Resorbed alveolar processes result from a combination of pneumatization of the maxillary sinus, the effects of periodontal disease, and physiological bone resorption. Therefore, various techniques have been proposed in order to achieve the necessary bone volume for the insertion of implants in the atrophic posterior maxilla. (1-4) During the past few decades, maxillary sinus augmentation has been shown to be the most predictable of the preprosthetic surgical techniques used to enhance bone volume for the placement of dental implants in previously compromised sites. (5-8)

Although there have been some modifications, the most common approach is the Lateral Wall Sinus Floor Elevation (LWSFE), whereby an osteotomy "window" in the lateral wall of the sinus is made for access, sinus membrane elevation and packing the floor of the sinus with a graft material. (1-5) Implants can be placed simultaneously with the grafting procedure or after a healing and graft consolidation period of 4 to 9 months. Elevation of the sinus membrane can also be accomplished with the transcrestal approach to the maxillary sinus, known as the Bone Added Osteotome Sinus Floor elevation (BAOSFE) that has been advocated as "minimally invasive". (3,4,9) However, some limitations related to these techniques have been reported. (7,10,11) In order to reduce these complications, other approaches have been proposed, including, but not limited to, the

use of short implants and Osteotome-Assisted Sinus Augmentation (OASA) technique. (12-20)

It is necessary to define case selection criteria according to the remaining crestal bone and the anatomy of the sinus cavity. The purpose of this review was to discuss the indications, contraindications, limitations, and case selection criteria used to determine the most predictable treatment options of the different techniques.

MATERIALS AND METHODS

A search of the literature was performed focusing on techniques related to the sinus augmentation procedure. Clinical data in this study was obtained from the anonymous Implant Database (ID) at the Ashman Department of Periodontology and Implant Dentistry at the New York University College of Dentistry (NYUCD) Kriser Dental Center. This Data was extracted as deidentified information from the routine treatment of patients. The ID was certified by the Health Insurance Portability and Accountability act (HIPAA) and approved by the University Committee on the Activities Involving Human Subjects (UCASHS). A computer search of electronic databases from MEDLINE and PUBMED at the Waldman Library at the NYUCD Kriser Dental Center was performed. Keywords such as "maxillary sinus," "sinus lift," "sinus augmentation," "sinus elevation," "sinus graft," "bone grafting," "dental implants," and "endosseous implants" were used, alone and in combination, to search the databases. Non-

English language publications were excluded. The search was limited to studies involving human subjects. Restrictions were not placed regarding the type of study design.

RESULTS

A total of 15 articles from reviewed journal published in English were collected from a search performed using Medline and Pubmed at the Waldman Library at the NYUCD Kriser Dental Center. The following guideline tables are the result of this literature review (TABLES 1, 2).

| Residual Bone Height (mm) | Procedure |
|---------------------------|--|
| <4 | Lateral wall, staged approach (delayed placement)* |
| 4-7 | OASA Technique |
| 8-10 | Osteotome Technique |

Table 1. Treatment options for atrophic posterior maxilla for single implant. *Simultaneous implant placement if primary stability is achieved (V-Shape sinus).

| Residual Bone Height (mm) | Procedure |
|---------------------------|--|
| <4 | Lateral wall, staged approach (delayed placement)* |
| 4-7 | Lateral wall, simultaneous placement |
| 8-10 | Osteotome Technique |

Table 2. Treatment options for atrophic posterior maxilla for multiple implants. *Simultaneous implant placement if primary stability is achieved (V-Shape sinus).

DISCUSSION

Due to the improvement of surgical techniques and the progress of research in the field of biomaterials, excellent outcomes have been reported for implant-supported rehabilitations in the atrophic posterior maxilla in the past years. (21,22) The most commonly utilized augmentation method for maxillary sinus reconstruction was first presented by Tatum 19772, and published by Boyne and James in 19801, using a window through the lateral wall of the alveolus for sinus access. The LWSFE technique has been widely described in the literature and is recommended with a residual bone height less than 4 to 5 mm. This procedure has been shown to be highly predictable for implant therapy with an overall implant survival rate well beyond 90%. 5,6,7,23 Advantages of the lateral window (LWSFE) approach to the sinus include direct view of the sinus cavity, access to the Schneiderian membrane, and an appropriate graft material placement15 (Fig.1, 2). However, this procedure presents the disadvantages of prolonged time, cost, and morbidity for the patient. (24,25)

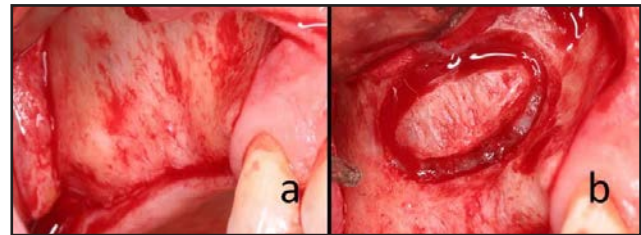


Fig. 1a. Intraoperative view of lateral wall of the maxillary sinus with Full thickness flap; Fig. 1b: Osteotomy of lateral wall window.

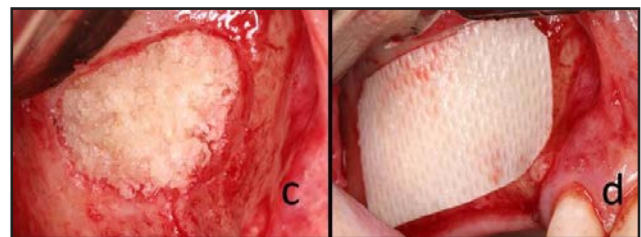


Fig. 1c: Placement of bone graft material in the sinus cavity; Fig. 1d: Resorbable membrane secured over the lateral window.

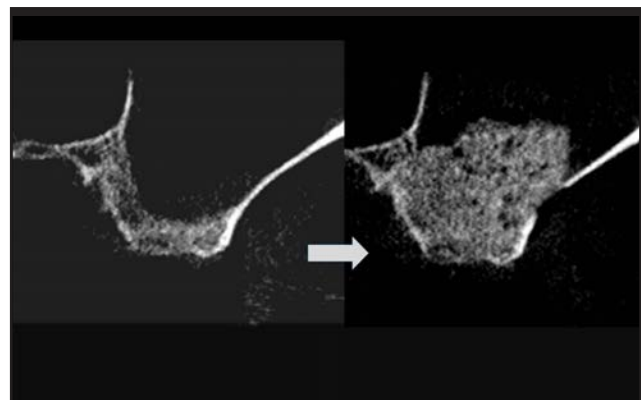


Fig. 2. Paraxial CT scans of sinus taken pre and post surgery.

To reduce complications and trauma that may occur using the lateral wall approach, different techniques have been proposed. The transcresal approach to the maxillary sinus (BAOSFE) has been advocated as ‘minimally invasive’ because of the undisturbed vascularization of the graft and less postoperative morbidity.4,9 According to standard protocol, the osteotome technique should be used when the ridge height is greater than 4 to 5 mm where implants are placed simultaneously with the elevation of the sinus floor (Fig.3). (3,4) Recently, a systematic review of the literature showed that crestal sinus lift can be an effective treatment option, reporting a mean weighted survival rate of 95% after 5 years of function.26 The same review also showed that the majority of failures occurred during the first year after treatment. However, limitations of this procedure include: limited accessibility and visibility for elevation of the sinus membrane and inability to diagnose and treat membrane perforations. (27,28,10) When the membrane is lifted more than 3 mm, the risk of membrane perforation increases significantly. (29,30) The use of an endoscope has been proposed to diagnose the membrane perforation during BAOSFE, increasing the cost and time of the procedure. (29,30) Thus, in cases where crestal height is 4-7 mm and an implant length of 10-13 mm is desired, the sinus membrane will be lifted greater than 3mm, increasing the risk of membrane perforation. An additional complication reported following the use of osteotomes is paroxysmal positional vertigo. (9)

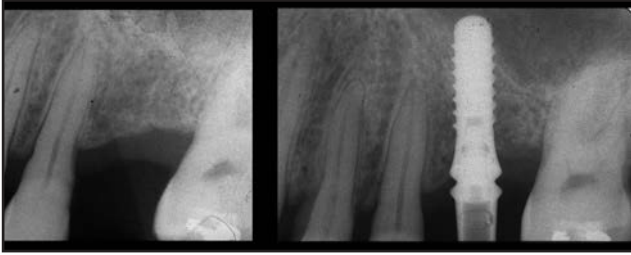


Figure 3. Periapical X-Rays of implant placed using BAOSFE technique, prior to surgery and 6 months post-surgery.

A modified transcresal approach with a vertical slot osteotomy (OASA technique) was proposed to provide good visual access in order to reflect the Schneiderian membrane at the inferior border of the sinus floor, avoid perforation of membrane, obtain access to repair membrane perforation, and have control of bone graft placement.(15) Drilling with direct vision and protection of the membrane avoided the trauma of the osteotome touching the membrane, which also decreased the chances of perforation related to the tapping sequence.(31,32) However, this procedure may increase time and morbidity to the patient. (15)

Currently, which bone graft material is most effective for these techniques is unknown. A number of clinical studies using a variety of autogenous bone grafts, allografts, xenografts, and alloplast in the posterior maxilla have been conducted and were discussed in a number of systematic reviews. (5-8,33-37) As described in the literature, such heterogeneity had no relevant effect on the clinical outcomes. (38,39) Although, sinus augmentation without graft have been reported successfully using lateral wall or osteotome procedures. (40,41) Moreover, no significant difference in outcomes were reported between studies using bone graft materials during sinus augmentation versus no graft material. (26) The surgical concern is how to achieve better blood supply and better stability for placed implants, while avoiding trauma.

Recently, short implants (less than 10 mm long) have been proposed as an alternative to sinus augmentation in order to rehabilitate posterior maxilla. (13,14) The use of short implants may reduce the occurrence of surgical complications and avoid augmentation procedures reducing patient's discomfort. (13,14,42) Prior to placement of short implants the residual bone height and width must be evaluated carefully. There must be sufficient residual volume to accommodate the implants ensuring primary stability. The use of short implants is promising but needs further investigation to be considered as effective as the other techniques in the long term. (43)

A careful evaluation of the sinus anatomy is mandatory prior to any surgical procedure involving the sinus. Studies by Avila et al (44) and Soardi et al (45) reported that a direct relation exists between sinus morphology and vital bone formation. The results of these studies demonstrated that sinuses with a narrow horizontal width and greater exposure of the medial and lateral walls showed a greater percentage of vital bone than sinuses with a wider width and less surrounding bone exposure. They showed that significant time is necessary for graft maturation, especially in wide sinuses. Since the blood supply to the sinus is critical for healing and bone formation any factor that brings this supply closer to the graft material would be expected to improve healing. For example, a sinus with a narrow horizontal width, closer proximity of surrounding walls, and V-shaped allows better blood supply and better stability when implants are placed simultaneously. (Fig. 4, 5) The implants will support the Schneiderian membrane and the site can heal even without adding bone grafting. In narrow maxillary sinuses, the higher amount of remaining residual crestal bone and presence of slope, the osteotome procedures may be recommended. A smaller width and height would allow

cells and healing proteins less distance to migrate. However, wide, U-shaped sinuses may provide less chances of blood supply. For cases with less of crestal bone and a flatter sinus floor in wide sinus, a conventional sinus augmentation with lateral wall procedure may provide more predictable outcomes.

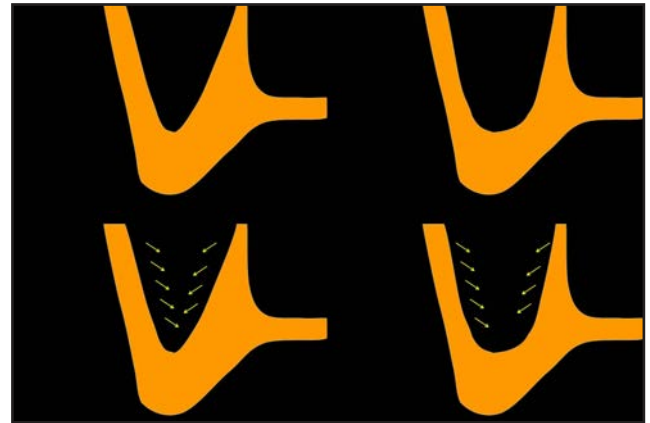


Figure 4. Relation between sinus morphology and vital bone formation.



Figure 5. Implant stabilization regarding the sinus shape (V-shaped vs U-shaped)

CONCLUSIONS

The primary purpose of sinus lift procedure is to create sufficient bone structure to allow implant placement and its posterior prostheses in a predictable way. Which technique to use depends on the ability and experience of the operator and the anatomical characteristics of the remaining bone. Based on the remaining bone, the following guidelines are suggested: with a residual bone height (RBH) of 4mm or less, a LWSFE procedure is recommended for single or multiple implant placement; with 4-7mm of RBH, a OASA technique is recommended for single implants and a LWSFE for multiple implant placement; with more than 7mm of RBH, BAOSFE can be used. Simultaneous implant placement is recommended whenever primary stability can be obtained, this occurs more often in V-shaped sinuses.

Using the proposed guidelines, careful case and material selection corresponding to different indications can be beneficial to achieve predictable treatment outcomes in the posterior atrophic maxilla. Even though sinus lift procedures have been thoroughly studied for several years, further studies including sinus anatomy should assess improvements in this field.

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