The Effects of Sinus Membrane Pathology on Bone Augmentation and Procedural Outcome Using Minimal Invasive Antral Membrane Balloon Elevation

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Membrane pathology tends to complicate the postprocedural course of open sinus lift by ostio-meatal complex (OMC) obstruction and consequent acute sinusitis. The objective of this study was to evaluate the outcome of subjects with considerable sinus membrane pathology undergoing maxillary sinus floor augmentation and simultaneous implant placement using the minimal invasive antral membrane balloon elevation (MIAMBE) method. This study was a retrospective chart review of MIAMBE procedures performed in the presence of significant sinus membrane pathology. Sixteen patients with maxillary sinus membrane thickening in well-ventilated OMC as determined by dental computerized tomography underwent sinus augmentation and simultaneous implant placement using the MIAMBE technique. All 16 procedures were successfully concluded without significant procedural or postprocedural complications or implant failure. Post MIAMBE membrane pathology regressed or disappeared in 8 patients (50%) or remained unchanged in 6 patients (37.5%), while in 2 patients the sinus membrane pathology was limited to evaluation by periapical X rays. Sinus augmentation using the MIAMBE technique can be performed safely in asymptomatic patients in the presence of sinus membrane pathology if the OMC is not obstructed. In a significant proportion of these cases, complete resolution of the membrane pathology after MIAMBE is observed. When compared to open sinus lift, OMC obstruction is less likely to occur when employing the MIAMBE method.

Key Words: maxillary sinus, membrane pathology, polyps, ostio-meatal complex, maxillary sinus lift, bone augmentation, implants, sinusitis, MIAMBE

INTRODUCTION

Incidental sinus pathology is seen in up to half of the subjects undergoing cone-beam computerized tomography scan of the maxillary sinus. The predominant pathology is membrane thickening, polypoid masses or cysts, and acute sinusitis. Several etiologic factors contribute to the pathogenesis of sinus membrane pathology: environmental pollution, allergens, smoke, immune and inflammatory disorders (like sarcoidosis), rhinogenic (anatomic mechanical ob-
struction due to septum/turbinate issues) infectious agents (viral, bacterial and fungal), esophageal reflux, and immune deficiencies. Etiologic factors can also be genetic or drug-related (aspirin).

Odontogenic infection (typically mixed aerobic and anaerobic infection), and especially periodontitis or intrasinus foreign body, may result in marked mucous membrane thickening and sinus membrane pathologies. If the process occupies the sinus floor it may perforate the Schneiderian membrane.

The most frequently encountered histopathologic changes within the maxillary antral lining include submucosal edema/congestion, eosinophilia, basement membrane thickening, goblet cell hyperplasia, and dystrophic calcification. Frequently marked morphologic changes are noticed. The mucosal appearance can be classified morphologically by computerized tomography (CT) scan based on appearance (normal, rounded, circumferential, irregular, complete, and cystic vs polypoid) and thickness.

The commonly encountered pathologies include cyst-like structures (like retention and oroantral/radicular cysts, pseudocysts, and mucocceles) and solid or polypoid masses (oroantral and antrochoanal polyps and neoplastic disease). While most cystic masses are asymptomatic, incidental imaging findings of certain polypoid masses (like antrochoanal polyps and neoplastic masses) require expert consultation, histological assessment, and surgical intervention.

Open maxillary sinus lift results in the activation of inflammatory mediators and marked swelling related to tissue edema and hemorrhage. Generally, the larger the exposed area, the more extreme is the postsurgical inflammatory reaction. These changes promote transient maxillary sinusitis, which is the most frequent post sinus-lifting complication. Although the diagnostic criteria used are not standardized, these adverse events have been reported in 0%–27% of cases in clinical studies. When standard diagnostic ear, nose, and throat (ENT) criteria were employed, subacute maxillary sinusitis developed in 4.5% of the patients undergoing sinus lifting, while postelevation chronic maxillary sinusitis was reported in 1.3% of patients. The development of a secondary infection can potentially lead to bone graft loss.

While membrane pathology serves as a relative contraindication to the performance of open sinus lift, the data regarding the procedural results and long-term outcome of this pathology after minimal invasive antral membrane balloon elevation (MIAMBE) are unknown.

The objective of this study was to evaluate the outcome of subjects with considerable, albeit asymptomatic, sinus membrane pathology undergoing sinus floor augmentation and simultaneous implant placement using the MIAMBE method.

**Methods**

We retrospectively reviewed all MIAMBE cases performed in the period between November 2006 and March 2011 in the presence of considerable sinus pathology. Patients with preprocedural obstruction of ostio-meatal complex (OMC) were not considered candidates for sinus lift procedure. The membrane pathology was characterized by its appearance on the CT scan (convex, dome shape straight, circumferential, or concave) and its dimensions. Pathology measurements were done by panoramic view for mesiodistal (horizontal) length of the lesion and by coronal view for superior-inferior (vertical height) measurements.

**Results**

A total of 16 cases were evaluated. Demographic, clinical, and membrane pathology characteristics are displayed in Table 1. There were 9 men and 7 women, with ages ranging from 26 to 64. Four patients (25%) were active smokers. None of the patients reported sinus-related symptoms.

Table 2 summarizes the results of the follow-up on the membrane pathology. The mean (SD) duration of follow-up was 12.18 (10.77) months (with a range of 6–50 months). The mean (SD) preprocedural vertical height of the membrane pathologies was 15 (4.8) mm, while the mean (SD) horizontal length was 26 (4.9) mm.

The procedural success was 100%. None of the patients developed postprocedural complications, sinus-related symptoms, or implant loss. During the follow-up period, 8 patients (50%) demonstrated complete resolution of the sinus membrane pathology; in 6 cases (37.5%) the sinus pathology remained unchanged, while 2 cases (12.5%) did not undergo a follow-up CT scan evaluation but remained symptom free.

Presented are 2 representative cases in which...
membrane pathology regressed after MIAMBE, bone augmentation, and implant placement.

**CASE 1**

A 26-year-old woman was referred to sinus lift and bone augmentation for reconstruction of tooth number 3 (maxillary right first molar). CT scan (Figures 1 through 3) demonstrated membrane pathology in the right maxillary sinus. The bone height and width at the implant site of tooth number 3 (cut 28) were 3.25 mm and 10.5 mm, respectively (Figure 3). The patient was offered and consented to undergo MIAMBE.

The details of the procedure were described previously.27 A minimal mucoperiosteal flap was performed to expose the alveolar crest. After drilling with a 2-mm bur up to 1 mm below the sinus floor,

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age, y/Sex</th>
<th>Smoker</th>
<th>Sinus Symptoms</th>
<th>Membrane Pathology Appearance</th>
<th>Area of Sinus Augmentation and Implant Placement</th>
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<tr>
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<td>No</td>
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<tr>
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<td>3-4</td>
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<td>3</td>
<td>56/F</td>
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<td>3-4</td>
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<td>14</td>
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<tr>
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<tr>
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<td>15 + sinus augmentation at 14</td>
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**TABLE 2**

Follow-up of membrane pathology

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<th>Progression of Pathologic Process</th>
<th>Sinus Symptoms</th>
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*CT indicates computerized tomography.
the osteotomy was enlarged to 2.9 mm diameter with the MIAMBE osteotome. Bone graft material (Mineross, BioHorizons, Birmingham Ala) was inserted into the osteotomy, and subsequently the sinus floor was fractured. The membrane integrity was assessed by Valsalva maneuver. Bone graft material was injected again into the osteotomy and the screw-tap was tapped into the osteotomy. After screw-tap removal and evaluation of sinus membrane integrity, the metal sleeve of the balloon-harboring device was inserted 1 mm beyond the sinus floor, and the balloon was inflated slowly (1 mL contrast volume resulting in 11-mm elevation) with the dedicated indeflator (Figure 4). Once the desired elevation was obtained, the balloon was deflated and removed.

After balloon removal, the membrane integrity was assessed by: (1) direct membrane visualization using the dedicated suction syringe and (2) up and down movements of blood within the osteotomy during inspiration and expiration. Following verification of membrane integrity, bone graft was injected.
into the sinus (Figure 5), which was followed by implant placement (SLT 3.75/13 Hi-Tech Implants, Herzlia, Israel) and primary closure (Figure 6).

Seven months later, CT scan revealed satisfactory sinus floor augmentation (Figure 7) and resolution of the sinus membrane pathology at the area of tooth number 3 (Figure 8). Another finding was the regression in volume of the right and left inferior turbinate.

**Case 2**

A 55-year-old man was referred to our clinic for upper jaw rehabilitation. Dome-shaped Schneiderian membrane pathology was observed in the left sinus on the panoramic view (Figure 9) and on the coronal (Figure 10), axial (Figure 11), and sagittal views (Figure 12) of the CT scan. In addition, a septum which divides the sinus into 2 compartments was detected. After inserting implants at sites 11 and 12 (maxillary left cuspid and first bicuspid), sinus floor elevation with the MIAMBE procedure was performed distally (Figure 13). At site number 14 only sinus floor elevation and bone grafting were done due to concerns regarding insufficient primary implant stability (Figure 14). At site number 17 (at the corner of the septum still in the anterior compartment), MIAMBE and simultaneous implant placement were done (Figures 15 and 16). Four and one-half months later, CT was performed. Most of the membrane pathology resolved (Figure 17), and an implant was placed on site number 14 (Figure 18).

**Discussion**

Membrane pathology can potentially complicate the postprocedural course of open sinus lift by OMC obstruction and acute sinusitis. It is essential for the practitioner engaged in maxillary sinus imaging and intervention to be able to assess sinus pathologies and learn to recognize and differentiate between benign incidental imaging findings and masses that require expert consultation, histologic confirmation, and surgical intervention.

It is also essential for the practitioner to understand that the presence of certain pathologies (e.g., moderate-size mucoceles) should not be a contraindication to sinus floor augmentation and implant placement, especially if the patient has no sinus-related symptoms and patent OMC.

When in doubt, the presence of sinus pathology should prompt a referral for ENT consultation prior to any sinus lift procedure.

Any sinus lift procedure can potentially result in mechanical obstruction or functional impairment of
the physiologic maxillary drainage into the middle meatus, especially in the presence of sinusitis or sinus membrane pathology. Potential contributing mechanisms are:

1. Transient inflammatory periosteal and tissue edema and swelling.
2. Anatomic distortion secondary to excessive elevation of the maxillary sinus mucosal floor, especially in the presence of anatomic barriers within the sinus (membrane pathology, septa).
3. Transient ciliary dysfunction and altered mucus composition resulting in predisposition to obstruction and infection.
4. Graft fragments passing through mucosal lacerations into the maxillary sinus and obstructing the natural ostium, especially if these are larger than 5 mm.

The use of MIAMBE does not preclude the requirement to consult an ENT specialist whenever ENT diagnostic and therapeutic intervention is deemed necessary. However, the minimally invasive nature of the MIAMBE method is less likely to result in inflammation, swelling, and anatomic distortion than the open sinus. Hence, MIAMBE is less likely to precipitate acute or chronic periprocedural sinusitis.

The MIAMBE procedure is extremely versatile and allows the practitioner to perform minimally invasive sinus lift in the complex setting of antral septa, unusual sinus anatomy and pathology, and single tooth implants.

These 16 cases support the notion that MIAMBE can be performed in patients with considerable, albeit asymptomatic, sinus membrane pathology, with excellent procedural results and absence of complications. Moreover, in half of the subjects who had follow-up CT scans, there was a complete regression of the sinus membrane pathology. Regression of sinus membrane pathology and thickness has been reported by other authors and may support the notion that certain membrane pathologic processes are alleviated by sinus lift.

It is possible that deficient maxillary bone mass results in a suboptimal barrier between noxious stimuli originating from the oral cavity and the sinus membrane even after extraction of the pathologic teeth. This can potentially promote inflammatory changes manifesting as “membrane pathology.” Membrane elevation and bone augmentation restores the barriers between the oral cavity and the sinus membrane, mitigating or alleviating the inflammatory reaction and resulting in resolution of some of these pathologic changes.

Similar observations were made by Chen and Cha, in their review of 1100 cases of minimally invasive hydraulic sinus lift. These authors report: “Otolaryngologists refer some patients to our offices specifically for the purpose of fortifying the natural barrier between the sinus and the oral cavities or to relieve pressure within the sinus. In all such cases our patients have reported improvement in their sinus problems, including fewer or no

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**Figures 7 and 8.** Figure 7. Sagittal (a), coronal (b), and axial (c) views. Seven months post minimal invasive antral membrane balloon elevation, the sinus membrane pathology has disappeared at site number 4. Figure 8. (a) Preprocedure. (b) Eight months postprocedure after prosthetic rehabilitation.
headaches, improved breathing, improved drainage, and elimination of sinus pressure. None of our patients complained of worsened sinus problems or newly formed sinusitis as a result of the procedure described.”

**CONCLUSION**

MIAMBE can be successfully performed in the presence of asymptomatic sinus membrane pathol-ogy that does not result in OMC obstruction and which does not require surgical intervention. In a short-term follow-up after MIAMBE, these pathologic processes remain asymptomatic and either regress or remain unchanged in size.

**ABBREVIATIONS**

- CT: computerized tomography

**FIGURES 9 AND 10.** **FIGURE 9.** Panoramic view showing dome (D) shape membrane pathology of left sinus membrane. **FIGURE 10.** Membrane pathology demonstrated in coronal view.
FIGURES 11–16. FIGURE 11. Membrane pathology (P) demonstrated in axial views. FIGURE 12. Membrane pathology (P) demonstrated in sagittal view and sinus septum (S). FIGURE 13. The minimal invasive antral membrane balloon elevation balloon (B) inflation. Note medial wall (MW) and floor (F) of the maxillary sinus. FIGURE 14. Sinus floor augmentation anterior compartment. Note bone graft (BG) material, sinus floor (F), medial wall (MW), and septum (S). FIGURE 15. Balloon inflation at the corner of the septum in the anterior compartment. Note bone grafting (BG) in the anterior compartment, sinus floor (F), medial wall (MW), and septum (S). FIGURE 16. Sinus augmentation followed by implant placement at site number 15 (27).

FIGURE 17. Coronal view and panoramic radiogram before and 4.5 months post minimal invasive antral membrane balloon elevation.
antral membrane balloon elevation at site number 14 (26).

OMC: ostio-meatal complex

ENT: ear, nose, and throat

MIAMBE: minimal invasive antral membrane balloon elevation

REFERENCES


