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## Fixation tack penetration into the maxillary sinus: A case report of a guided bone regeneration procedure complication

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### Summary

**Background:**

Guided bone regeneration (GBR) is an established and predictable procedure used to obtain adequate alveolar bone for the placement of dental implants. Anatomical challenges, such as the proximity of the maxillary sinus, may lead to complications during a GBR procedure. The purpose of this report is to present a unique and hitherto unreported complication of a GBR procedure, i.e., the penetration of a titanium fixation tack into the maxillary sinus.

**Case Report:**

A unique GBR is presented, where a titanium tack penetrated the maxillary sinus with subsequent migration and loss. Attempts to locate the tack visually during the procedure were unsuccessful. The GBR procedure was aborted and dental radiographs were immediately obtained. The patient was completely asymptomatic during the healing period. Eight weeks later a cone beam computed tomography revealed a non-inflamed sinus with no pathology evident. However, the tack could not be visualized. An otolaryngology consultation was requested and the ensuing sinus endoscopy did not reveal any evidence of the penetrated tack. It is thought that the loose tack migrated completely out of the sinus through the nasal passage.

**Conclusions:**

The use of a pre-operative cone beam computed tomography (CBCT) would have allowed the clinician to assess the exact thickness of the lateral wall of the maxillary sinus and better determine the ideal placement location and/or the feasibility of using a fixation tack in the posterior upper jaw.

**key words:**

**maxillary sinus • complication • guided bone regeneration • titanium tack**

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## BACKGROUND

The alveolar bone loss associated with periodontitis, along with the alveolar atrophy that inevitably occurs subsequent to tooth extraction in adults [1] and the potential post-extraction pneumatization of the maxillary sinus [2], can combine to result in severe vertical and horizontal bone loss in the posterior maxilla. In such cases, the clinician has to meet the challenge of building adequate bone three-dimensionally, prior to dental implant placement.

When extensive bone loss requires reconstruction of the alveolar process in the posterior maxilla, a commonly employed technique is guided bone regeneration (GBR) [3]. GBR is an established and predictable procedure prior to placement of dental implants, in which a barrier membrane is used for space maintenance over a defect and to exclude connective tissue ingrowth into the wound for a successful outcome [4]. The membranes are essential for a successful outcome because they act as a physical barrier to protect blood clots in the defect, exclude gingival connective tissue, and provide a secluded space into which osteogenic cells from the bone can migrate. The predictability of GBR outcomes depends, in part, on proper technique, which includes stabilization of the membrane [5,6]. Indeed, fixation of a barrier membrane has been reported to significantly reduce post-operative complication and premature membrane exposure [6]. Membrane stabilization can be achieved by different means, such as fixation screws, fixation tacks, or sutures [5]. When GBR is performed in the posterior maxilla, the proximity of the maxillary sinus may become an anatomical limitation [7].

The purpose of this report is to present a unique and hitherto unreported complication of a GBR procedure, i.e., the penetration of a titanium fixation tack into the maxillary sinus. Management of this complication, including otolaryngology consultation, is described.

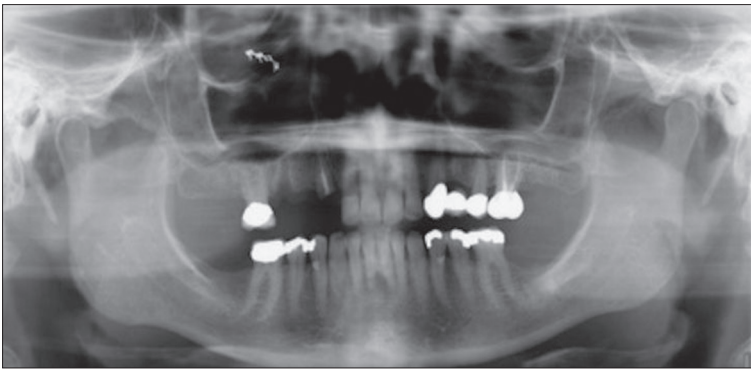
## CASE REPORT

A 68-year-old African American female was referred to the Ohio State University Periodontology Clinic for dental implant placement in the upper right quadrant, to restore the missing maxillary right first and second premolars and the hopeless right maxillary canine. The patient's medical history was positive for hypertension and hypothyroidism, both treated by medication. She reported taking amiloride, hydralazine, metoprolol and levothyroxine. The patient denied any history of sinus infections or diseases.

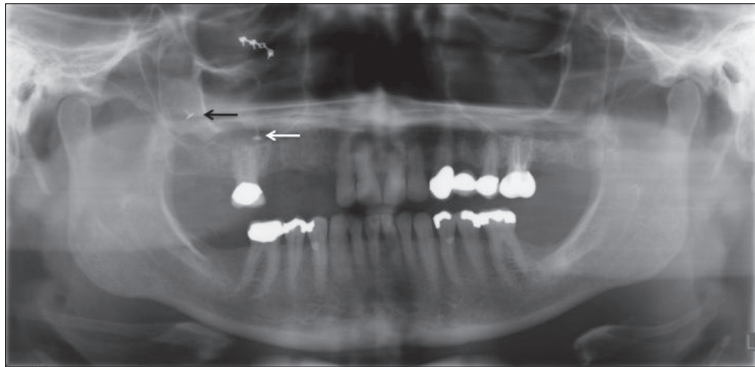
The dental history of the maxillary right quadrant included extraction of the second molar and first premolar several years prior, due to caries. Her maxillary right canine was fractured, deemed non-restorable and was treatment planned for extraction and replacement by an implant, while the second premolar had been extracted a few weeks prior to presentation. Clinical examination revealed ridge deficiency (HVC ridge classification: small combination of horizontal and vertical defect C-s) [8] in the area of tooth #4 to #5. Radiographic examination, using panoramic (Figure 1) and periapical radiographs (not shown), revealed a bony defect in the area of tooth #4 and the retained root of the canine. The maxillary sinus was free of abnormalities. The

treatment plan presented to and accepted by the patient included: GBR to restore the deficient ridge in the first and second premolar area, extraction and socket preservation for the canine, and implant placement.

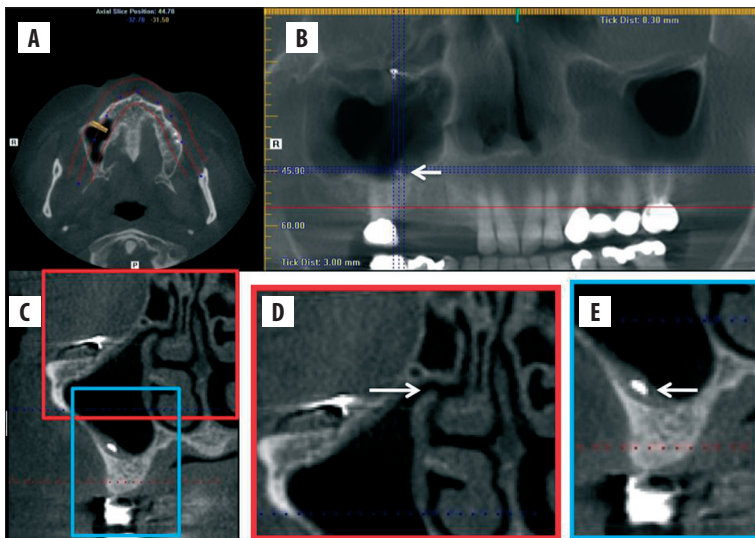
Surgery was performed under local anesthesia (2% lidocaine with 1:100,000 epinephrine). A crestal incision was made at the edentulous area of tooth #4 to #5 and connected with the sulcular incisions placed around tooth #3 and #6 to #7. A full-thickness flap was elevated and a buccal bony concavity was noted around tooth #4 and #5 upon reflection. The root of tooth #6 was atraumatically extracted and a fenestration defect identified at the apex. The bony concavity and the socket wall were grafted with 1 c.c. of freeze-dried bone allograft (Straumann AlloGraft GC<sup>®</sup>, Straumann USA LLC, Andover, MA) and a resorbable membrane. A 20×30 mm long-lasting collagen membrane (BioMend Extended<sup>®</sup>, Zimmer Dental Inc, Carlsbad, CA) was trimmed and adapted to the site. One titanium tack (AutoTac<sup>®</sup>; BioHorizons Implant Systems, Inc. Birmingham, AL) was secured through the membrane to the underlying bone mesial to tooth #3 (Figure 2; white arrow). A second tack placement was attempted for membrane fixation at the edentulous area corresponding to the apical area of tooth #4. However, upon tack delivery, the buccal cortical plate collapsed and perforation of the sinus membrane occurred with migration and loss of the tack. The GBR procedure was aborted and attempts to visualize and possibly remove the tack were unsuccessful. The patient was informed of the complication and radiographs were obtained. They revealed that the tack had drifted distal to the first molar area (Figure 2; black arrow). It was then decided to terminate the surgical procedure. An absorbable collagen wound dressing was placed over the sinus membrane perforation, a long-lasting collagen membrane adapted over the breached lateral bony wall, and flaps were repositioned and sutured for primary closure. At completion of the procedure the patient's blood pressure was increased and she developed a nosebleed. The patient remained in the dental chair until her vitals became stable and the episode of epistaxis ceased. Post-operative instructions were given and ibuprofen, chlorhexidine gluconate 0.12% oral rinse, amoxicillin (500 mg TID for 1 week), and oxymetazoline nasal spray prescribed. The patient was informed that additional radiographic assessment would be performed, using a cone beam computed tomography (CBCT), in 8 weeks and then a Caldwell-Luc procedure would be scheduled to retrieve the migrated titanium tack. The patient did not experience any significant post-operative complications during the healing phase and subsequent post-operative visits. The patient returned in 8 weeks for a CBCT. The CBCT (Figure 3) revealed that the maxillary sinus was clear with wide opening of the ostium (Figure 3D; white arrow). However, the location of the titanium tack lost during GBR procedure (Figure 2; black arrow) was not evident. The patient was then referred to an otolaryngologist for a consultation, approximately 2.5 months after the surgery. The otolaryngologist re-evaluated the CBCT images and performed a nasal endoscopy. The otolaryngologist was unable to locate the titanium tack at that time and believed it had migrated completely out of the sinus through the nasal passage. He re-consulted the patient 2 months later and performed another CBCT and second endoscopy. He could only identify the tack located mesial to tooth



**Figure 1.** Pre-operative panoramic radiograph: Note a titanium zygomatic plate that was previously placed and unrelated to this case report.



**Figure 2.** Post-operative panoramic radiograph immediately after tack displacement. The displaced tack is indicated by black arrow, while the non-displaced tack is indicated by a white arrow. Note the right maxillary canine area, where socket preservation was performed following extraction of the canine root.



**Figure 3.** Post-operative (8-week) CBCT. (A) Axial view of CBCT demonstrating view of interest. (B) Panoramic view of CBCT: non-displaced tack (white arrow). Tack superiorly to sinus is a titanium zygomatic plate previously placed and unrelated to this case report. (C–E) Coronal views demonstrating the non-displaced tack (white arrow in blue box) and a clear, open ostium (white arrow in red box). The displaced tack was not seen on these CBCT images.

#3 (Figure 3E; white arrow), which was positioned in the right-anterior-inferior-lateral portion of the maxillary sinus. It appeared to have a very thin covering of mucosa and there was no associated inflammatory response. The otolaryngologist again failed to locate the titanium tack displaced during the GBR procedure. Upon failure to observe the location of the tack after the second CBCT assessment, the assumption was made that the patient may have expelled the tack through the nasal passage. The patient healed uneventfully and was completely asymptomatic, thus the decision was made to leave the tack mesial to the first molar *in situ*. The patient was informed and understood the situation. The otolaryngologist recommended continuation of dental therapy with no other concerns; however, the patient decided not to continue the implant treatment due to the complications she suffered.

**DISCUSSION**

Membrane usage in GBR is crucial for a successful outcome. The importance of membrane fixation during a GBR procedure is not well-documented. However, micromovement of the membrane following the surgery was reported to reduce the bone regeneration by forming a soft tissue layer beneath the membrane [9]. Carpio et al. [6] investigated the effects of membrane fixation on GBR and they found that membrane fixation significantly reduced post-operative complication and premature membrane exposure.

Migration of foreign bodies in maxillary sinus is a relatively common occurrence in dental clinical practice. Numerous case reports and case series have been published documenting migration of foreign bodies into the maxillary sinus

[10–20]. Common foreign bodies associated with sinus perforation include endodontic materials [12], displaced fractured roots [13], dental impression materials [14], dental burs [15], sewing needle [16], amalgam fillings [17] and even dental implants [18–20]. Indeed, one of the most common complications for implant placement in the posterior atrophic maxilla is the invasion of the maxillary sinus, which may lead to infection and subsequently implant failure [21]. The possible mechanisms associated with the displacement of a dental implant into the hyperpneumatized maxillary sinus include the application of excessive force during implant placement and/or the lack of surgical experience [22]. The complication that occurred in this case during the GBR procedure is likely due to the unfamiliarity with the anatomic variations in the maxillary sinus and a lack of surgical experience. Therefore, a careful treatment plan, identification of the maxillary sinus anatomy, and good surgical technique may prevent this complication from happening.

Sinus pathology, such as sinusitis, may result following introduction of foreign bodies in the maxillary sinus, by interrupting mucociliary clearance or causing a tissue reaction. However, related infectious complications are apparently uncommon and sporadic [10,18,20,23]. Several case reports have documented migrated dental implants with the sinus remaining completely asymptomatic [19,20]. Implant migration in the sinuses can be associated with oro-antral communication and/or infection that, in addition to the maxillary sinus, may involve the ethmoidal [24], frontal [25] and sphenoidal [25,26] sinuses. Thevoz et al. [27] found that chronic maxillary sinusitis attributable to a dental foreign body is rare and overestimated. In his review, 9% of 197 maxillary sinusitis cases were classified as “odontogenic”. Intra-sinusal foreign bodies were identified in 5% of the cases: 2% were of dental origin, 1% were dental or radicular remnants, and 2% were “pseudo” foreign bodies of mycotic origin.

Two main approaches have been proposed for the removal of foreign bodies displaced in the sinuses and to treat the associated infectious complications. These include an intraoral approach with the creation of a bony window in the anterior-lateral wall of the maxillary sinus (Caldwell-Luc) [19,28] and a transnasal approach with functional endoscopic sinus surgery (FESS) [18,23]. The Caldwell-Luc procedure involves opening the sinus directly through the lateral cortical plate by making an osteotomy and visually assessing the area of interest. This is more invasive with increased patient morbidity [29]. FESS allows removal of displaced implants, treatment of paranasal sinusitis and recreation of adequate patency of the natural maxillary ostium with a minimally invasive procedure [25].

The hiatus semilunaris (or semilunar hiatus) is a crescent-shaped groove in the lateral wall of the nasal cavity just inferior to the ethmoidal bulla. It is the location of the openings for the frontal sinus, maxillary sinus, and anterior ethmoidal sinus. The ostium for the maxillary sinus (Figure 3D; white arrow) opens posteriorly in this groove and is the largest ostium within the semilunar hiatus. Kennedy et al. [30] described the normal size of the maxillary ostium to be 5×5 mm. The patency of this opening is the key to sinus health. When blocked, the normal function of mucociliary clearance in the sinus is inhibited. In the present case, it is likely that the displaced titanium tack may have been

expelled through the ostium, considering that the tack size is 2.5 mm. There are few reports of foreign bodies spontaneously expelled from the sinus through the ostium. Borgonovo et al. [31] and Pang et al. [11] have demonstrated that relatively heavy metallic objects, such as a dental implant, located in the maxillary sinus are able to migrate to the sinus ostia against gravitational force, by the aid of mucociliary action, and subsequently to be expelled from the nasal cavities. Furthermore, Barclay [13] described a case of a tooth root forced into the sinus and delivered from the pharynx 3 weeks later, as the patient coughed. Westermarck [32] reported on chloropercha root-filling particles forced into the sinus during root canal treatment of a maxillary first molar. These particles were able to migrate to and through the maxillary ostium, being spontaneously expelled from the nose. Collectively, these observations indicate the powerful ability of the mucociliary action to help clear the maxillary sinus.

## CONCLUSIONS

The use of a pre-operative CBCT would have allowed the clinician to assess the exact thickness of the lateral wall of the maxillary sinus and better determine the ideal placement location and/or the feasibility of using a fixation tack in the posterior upper jaw. In areas of thin bone the use of fixation tacks or screws should be attempted with extreme caution to avoid sinus penetration. In the case presented herein, the patient was completely asymptomatic and healed uneventfully with no further treatment needed. The decision to purposely remove foreign bodies from the maxillary sinus depends on patient signs and symptoms, as well as the size of the foreign body. Consultation with an otolaryngologist and radiographic examinations and analyses are necessary.

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## Conflicts of interest

None.

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