

Miniscrew Insertion and the Maxillary Sinus: An Endoscopic Evaluation

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As the use of miniscrews has become more routine in modern orthodontic practice, various studies have attempted to determine optimal sites for their insertion.¹⁻³ Several investigators have recommended the zygomatic crest—specifically, the buccal surface of the malar process above the first permanent molar—for skeletal anchorage during retraction of maxillary anterior teeth, intrusion of posterior teeth, and other orthodontic movements. This area may be particularly amenable to miniscrew insertion because its two cortical layers (buccal and sinus floor) will ensure primary stability if a screw of appropriate length is fixed bicortically.^{4,5}

The primary challenge to safe insertion of miniscrews in the zygomatic crest is the possibility of perforating the Schneiderian membrane and penetrating the antrum of the maxillary sinus.

Such perforations have been noted in as many as 40% of alveolar crest augmentations performed laterally⁶⁻⁸ and as many as 25% of augmentations performed transcristally.⁹⁻¹¹ Small, uncomplicated perforations may heal spontaneously,¹²⁻²⁰ but larger perforations in unfavorable areas can result in leakage of graft material, inflammation, and other complications.^{12,17,18,20} In recognition of these differences, Vlassis and Fugazzotto have proposed five perforation classes based on location and difficulty of repair.^{21,22}

Previous clinical and cadaveric studies have taken distance measurements at an angle to the occlusal plane, possibly underestimating the actual penetration of the screw through the crest as a basis for proposing a minimum safe thickness of at least 6mm.^{5,23,24} Authors have noted marked variations within and between individuals in terms



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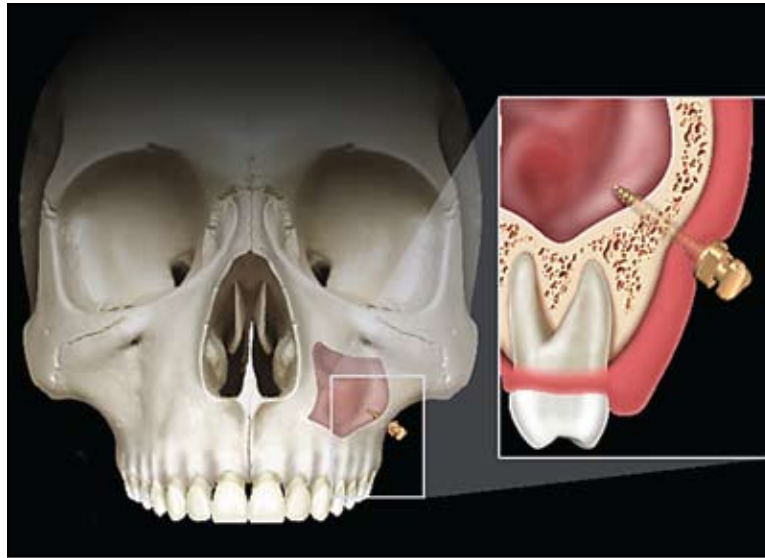


Fig. 1 Perforation of Schneiderian membrane and penetration into antrum by orthodontic miniscrew inserted near zygomatic crest.

of the morphology of the maxillary sinus,^{25,26} thickness of the sinus mucosa,⁹ radicular length and shape and buccolingual inclination of the maxillary teeth, incidence of antral (Underwood's) septa,²⁷⁻²⁹ and other factors that can increase the risk of perforation.

An analysis of Schneiderian membrane samples from 20 cadavers showed that perforation can be avoided with the use of light forces and appliances that are able to control the pressure exerted during surgery.³⁰ The critical perforation force is obtained by multiplying the burst tension (the maximum load at the time of membrane perforation) of the sinus membrane by the area of force transmission. Thus, when an osteotome is used to elevate the membrane, the area of transmission corresponds to the extreme surface of the instrument: the greater the diameter of the osteotome, the larger the force exerted.³¹ This rule also applies to other instruments such as the inflatable bulbs of balloon catheters,³² dental implants, and miniscrews.

A reliable method is needed to assess the relationship of the Schneiderian membrane and antrum of the maxillary sinus with the zygomatic crest in a patient for whom orthognathic surgery with miniscrew insertion is planned. We used sinus endoscopy to investigate this relationship in a series of cases.

Procedure

Informed consent was obtained from all patients, each of whom received general anesthesia before undergoing combined bimaxillary surgery. An otolaryngologist inserted a Karl Storz endoscope with 70° rigid optics, connected to video-recording equipment, into the maxillary sinus via the nasomaxillary ostium, corresponding to the middle meatus of the nasal fossae. The endoscope was then used to examine the anterior wall of the maxillary sinus at the zygomatic crest, above the root apices of the upper molars and premolars.

Orthodontic miniscrews (Vector TAS*) of different lengths and diameters were buccally inserted either between the second premolar and the first molar or between the first and second molars, at a 45° angle to the occlusal plane in each case (Fig. 1).

Case 1

A 21-year-old female patient scheduled to undergo combined bimaxillary surgery showed a rounded zone of radiopacity at the palatine root of the maxillary left first molar in preoperative radiographs (Fig. 2A). A 12mm Vector miniscrew

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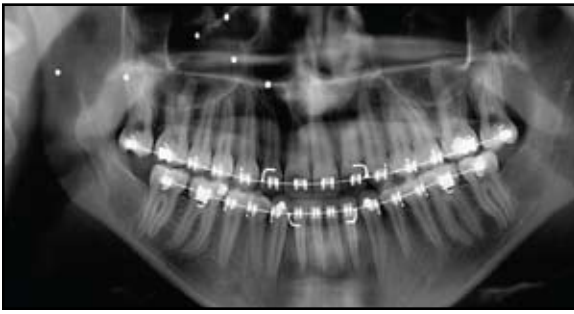


Fig. 2 Case 1. A. Radiopacity at palatine root of maxillary left first molar in 21-year-old female patient. B. Protrusion of apical part of screw near mucous cyst.

(2mm diameter) was inserted between the upper left second premolar and first molar, about 1mm above the line between the mobile mucosa and the adherent gingiva. Endoscopic investigation revealed protrusion of a mucous cyst into the maxillary sinus and of the apical part of the screw a short distance from the cyst (Fig. 2B). Mucous retention cysts in the maxillary sinus have been found in 1.4-9.6% of odontoiatric patients and 5.8% of orthodontic patients.³³

Case 2

In this 24-year-old female patient, we inserted a 12mm screw (2mm diameter) into the zygomatic crest 18-20mm above the maxillary occlusal plane and upper first molar, at an angle of 45-50° to the occlusal plane. Eight threads of the screw shank protruded into the sinus (Fig. 3).

Case 3

A 10mm screw (2mm diameter) was inserted in the zygomatic crest of a 24-year-old female patient, 18-20mm above the maxillary occlusal plane and upper first molar, at an angle of 45-50° to the occlusal plane. Three threads of the screw shank protruded into the sinus (Fig. 4).



Fig. 3 Case 2. Eight screw threads protruding into sinus of 24-year-old female patient.

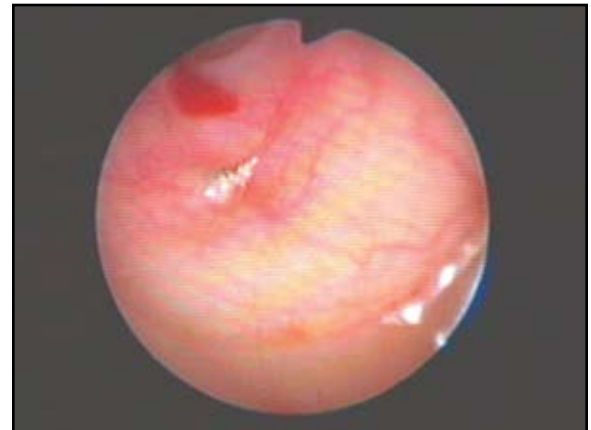


Fig. 4 Case 3. Three screw threads protruding into sinus of 24-year-old female patient.

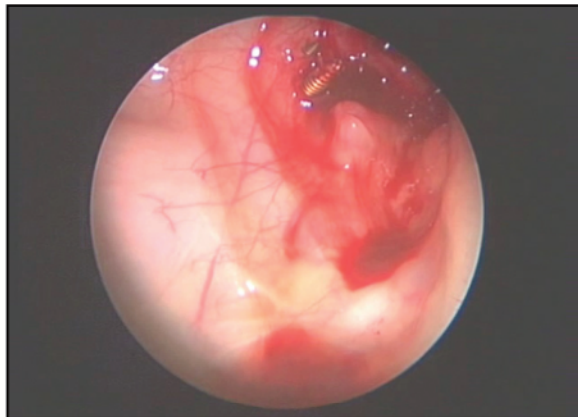


Fig. 5 Case 4. Convolutions in sinus floor caused by maxillary first molar roots, distinguished from protrusion of 8mm and 10mm screw tips into sinus of 28-year-old male patient.

Case 4

In a 28-year-old male patient, two miniscrews (10mm long, 2mm in diameter, and 8mm long, 1.4mm in diameter) were inserted a short distance apart between the upper first and second molars. The 10mm screw was placed immediately above the mucogingival junction, and the 8mm screw 1.5mm closer to the cranium. Endoscopic examination showed that the roots of the first molar and both screws were protruding into the sinus, but that the screws had been placed at a safe distance from the protruding root (Fig. 5).

Discussion

Sinuscopy (antroscopy) has long been used to assess pathologies of the maxillary sinus.^{34,35} This minimally invasive methodology can be employed both before sinus-elevation surgery, to evaluate the state of the maxillary sinus, and during the surgery itself, to inspect the bone-grafting procedure.²⁵ Detection of sinus pathologies before or during surgery can reduce surgical morbidity and can lessen the risk of developing periosteal mucosal perforations or oroantral fistulae, while maintaining control of the graft material.

Other advantages of this technique are that it can be used under local anesthesia, can be performed quickly, and produces minimal postoperative discomfort. The endoscopic probe can be introduced either through an incision made in the

lateral wall of the sinus at the canine fossa or through the nasomaxillary ostium, corresponding to the middle meatus of the nasal fossae.

The maxillary posterior region is one of the most commonly employed miniscrew anchorage sites for movements such as molar or premolar intrusion, vertical control of the posterior segments, and retraction of the anterior teeth. Regardless of individual variations in the thickness of the mucosa and buccal osseous cortex, miniscrew insertion in this area can easily result in perforation of the maxillary sinus cavity and rupture of the Schneiderian membrane, although perforations less than 2mm in diameter are not considered serious enough to warrant miniscrew removal.³⁶ Some clinicians have noted anecdotally that non-sedated patients are able to feel sinus membrane perforation, which would serve to alert the practitioner of the situation. We have not seen such reactions, however, even when using only topical anesthesia.

In any case, clinicians need to assess several fundamental aspects, such as the state of the maxillary sinuses, before proceeding to endoscopy. Smoking habits must also be considered, given that the Schneiderian membrane may be extremely thin, fragile, and atrophic in such patients. A careful history and radiological examination should reveal factors that may predispose patients to membrane perforation.

In cases of severe pathology of the maxillary sinus, the clinician should refer the patient to an otolaryngologist for resolution of the underlying disease before miniscrew insertion. Likewise, smokers should be encouraged to abstain from tobacco for at least a week before this kind of treatment. Mild sinusitis is not an absolute contraindication to miniscrew insertion; the patient simply should be encouraged to inform his or her physician of any change in signs or symptoms after the procedure. Any miniscrews causing chronic pain should obviously be removed.

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