

Prevention and the Management of Complications Using the Zygoma Implant: A Review and Clinical Experiences

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Purpose: To review potential complications that may occur using the zygoma implant published in the literature as well as complications encountered by the primary author. Solutions for prevention as well as the management of such complications are also discussed in detail. **Materials and Methods:** The authors have reviewed and outlined reports discussing the etiology as well as the management of potential complications associated with the use of the zygoma implant and have offered recommendations for the management of these complications. **Results:** Predictable clinical solutions are offered for the identification of the cause as well as the management of complications, including orbital involvement, intracranial involvement, paresthesia of V2, subperiosteal infections, overextended apical extension, vestibular dehiscence, failed zygoma implant, fractured implant, and management of sinus infections. **Conclusion:** A comprehensive knowledge of the specific steps for the proper execution of this complex procedure will allow for a predictable outcome as presented by the systematic reviews of the zygoma implant, which have reported a cumulative survival rate of 96.7% to 97.8%. Understanding the cause, the prevention, as well as the management of potential complications is imperative for the contemporary surgeon using the zygoma implant. *INT J ORAL MAXILLOFAC IMPLANTS* 2018;33:e135–e145. doi: 10.11607/jomi.6539

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The zygomatic implant is another means to establish posterior support in patients who lack remaining alveolar bone in Zones 2 and 3.¹ Multiple studies have documented the successful use of the zygoma implant, including a 94.2% cumulative survival rate (CSR) reported by Brånemark et al in their 1977 retrospective article.² Bedrossian and Aparicio et al reported a CSR of 97.25% and 97.71% in their 2010 and 2012 prospective reports using the zygomatic implant in conjunction with immediate loading with 7- and 10-year

follow-ups, respectively.^{3,4} In more contemporary reports, the success of this implant has also been discussed in systematic reviews with favorable outcomes.

In 2013, Chrcanovic and Abreu reported a 96.7% success rate, with a majority of the failures occurring during the osseointegration period,⁵ and in 2014, Goiato et al reported a success rate of 97.86% while following 1,541 zygoma implants.⁶

MATERIALS AND METHODS

The authors identified published reports of complications related to the use of the zygoma implant using the PubMed search platform. Combining the authors' own clinical experience with published reports, a list of potential complications with emphases on the prevention as well as the treatment of such complications was compiled.

RESULTS

The potential problems that may occur using the zygoma implant include:

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- orbital involvement
- intra-cranial involvement
- infraorbital nerve (V2) paresthesia
- subperiosteal infections
- overextension of the zygoma implant apex
- the “other zygoma implant”
- vestibular dehiscence
- failed zygoma implant
- fractured implant
- sinus infections

Orbital Involvement

The zygoma implant is unique, as it engages a distal bony site, the zygoma bone, at its apex and the maxillary alveolar crest at its platform. Bedrossian and Brånemark have described the trajectory of the osteotomy and therefore the zygoma implant in their surgical protocols chapter in Fonseca’s textbook of oral and maxillofacial surgery.^{7,8} The suggested trajectory allows the zygoma implant to potentially be “quad cortically” stabilized.

The trajectory of the zygoma implant is such that it passes through the lingual plate of the residual maxillary alveolus, the base of the maxillary sinus, the lateral-posterior corner of the maxillary sinus, and the body of the zygoma bone, finally perforating the lateral cortical wall of the zygoma bone. The aforementioned trajectory allows for a quad-cortical stabilization of the zygoma implant. To place the zygoma implant in the proper trajectory, the operator must understand and have adequate training prior to attempting this procedure.

The improper entrance angle of the initial round drill into the floor of the maxillary sinus may potentially establish a trajectory following the “yellow” line into the orbit instead of the “red line,” which will place the osteotomy within the body of the zygoma bone (Fig 1).

By following the yellow axis, the drills would have a more medial trajectory, and their path would be as follows: the palatal bone, the base of the maxillary sinus, and the roof of the maxillary sinus, with final perforation of the floor of the orbit.

To avoid the more medial trajectory of the drill, anatomical landmarks have been described and illustrated in the literature to establish the proper trajectory of the drills.⁷⁻⁹

Opening a window into the maxillary sinus allows direct visualization of the “lateral-superior corner” of the maxillary sinus roof. The tip of the round drill is directly visualized as it approaches the lateral-superior corner of the roof of the maxillary sinus from its starting point at the maxillary alveolar crest.

One published article¹⁰ describes the damage to the lateral rectus muscle with loss of the patient’s ability to move the right eye laterally, therefore losing their

lateral gaze on the affected side (Fig 2). In this particular incident, the medial trajectory of the drill and the implant had entered the orbit (Fig 3) and separated, transecting the lateral rectus muscle from its insertion on the lateral portion of the globe, eliminating the patient’s lateral gaze.

Even with the dramatic postoperative radiograph showing the implant within the orbital cavity, the patient’s vision was intact and the implant osseointegrated. The authors were stressing the point that, due to the extremely fragile composition of the lateral rectus muscle, once it is detached or transected, it is extremely difficult or impossible to reattach and establish normal lateral gaze for the affected eye.

The potential for damage to the content of the orbital housing may occur if the apex of the implant enters the orbital floor as shown in a different patient’s postoperative radiograph (Fig 4).

To avoid this complication, the surgeon must understand the importance of direct visualization of the tip of the implant drill at all times and especially as the drills perforate the lateral cortex of the zygoma bone. The surgeon must at all times have command of the trajectory of the long drills used, ensuring the proper trajectory of the zygoma implant, referred to as “ad Modum Brånemark protocol”. The direct visualization of the tip of the drill exiting the lateral cortex of the zygoma bone not only allows the surgeon to maintain the proper trajectory and avoid entrance into the orbit, but is the only way to use the “depth gauge” to measure the proper length of the zygoma implant to place.

Solution and Clinical Management. It is critical to emphasize that penetration into the orbit or the infratemporal fossa is easily preventable by direct visualization of the tip of the drills as the osteotomy sites are prepared. To avoid this complication, understanding of the trajectory of the zygoma implant is critical when considering the use of this implant. Direct visualization of the path of the drills is recommended with special attention to understanding and visualizing the superior lateral corner of the maxillary sinus, which corresponds to the apical osteotomy site of the zygoma bone (Fig 5). The tip of the initial 2.9-mm drill must be seen exiting the lateral cortex of the zygoma bone before continuing with the preparation of the osteotomy.

Intracranial Placement

A single article in the literature describes the intracranial placement of the apical portion of a zygoma implant.¹¹ In this case, the improper use of a zygoma implant as a “pterygoid implant” led to the apical portion of the zygoma implant penetrating the middle cranial fossa (Fig 6). The irritation of the zygoma implant beneath the dura mater causes chronic migraines for the patient. The treatment to resolve the chronic

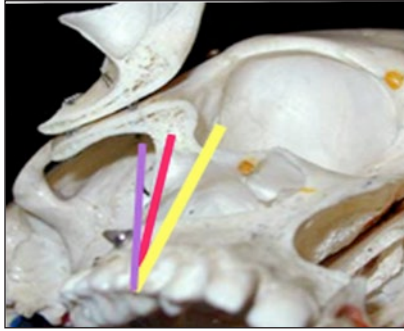


Fig 1 The red line demonstrates the correct trajectory of the osteotomy and the zygoma implant.



Fig 2 Lack of lateral gaze with the patient's right eye.

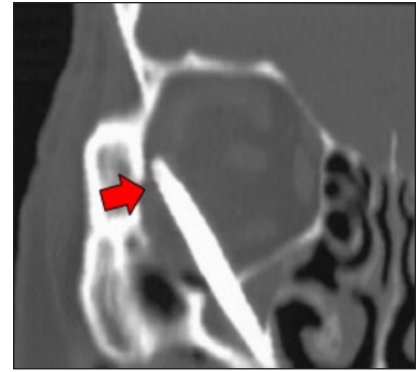
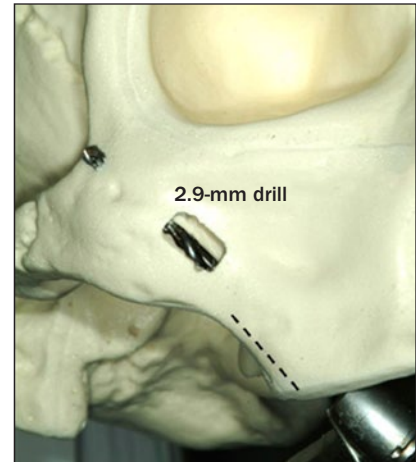
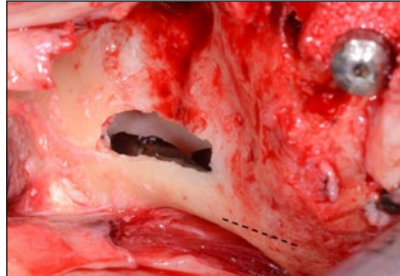


Fig 3 Postoperative scan of the orbital position of the zygoma implant.



Fig 4 (Left) Improper position of the zygoma implant within the orbit.

Fig 5 (Below and right) Direct visualization of the tip of the drill is essential at all times.



headaches would involve an apicoectomy of the tip of the zygoma implant via craniotomy; however, the patient declined the craniotomy and therefore continues to have the symptoms caused by the improper use of the zygoma implant.

Solution and Clinical Management. The use of the zygoma implant in trajectories where a “pterygoid” implant would be considered is contraindicated. The use of the zygoma implant by practitioners who are not familiar with the maxillofacial anatomy or the protocol for the use and the surgical placement of the zygoma implant is also not recommended.

Infraorbital Nerve (V2) Paresthesia

The infraorbital nerve typically exits 6.10 to 10.9 mm (0.240 to 0.429 in) from the infraorbital margin.¹² During the surgical procedure, it could be damaged by excessive subperiosteal dissection, inadvertent transection, or inadvertent compression by the tip of the retractor causing postoperative paresthesia, anesthesia, or dysesthesia.

As in all surgical techniques around nerve foramina, it is imperative to be cognizant of the position of the nerve exiting the foramen as well as the degree of stretch applied to the nerve during soft tissue and flap manipulation.

A 2013 systematic review by Chrcanovic and Abreu⁵ discusses 15 reported cases of temporary (V2) infraorbital nerve paresthesia, which all resolved over time.

Solution and Clinical Management. To prevent stretch injuries to the infraorbital nerve, careful dissection and releasing the soft tissues to allow passive retraction will limit the “stretch” of the nerve (Fig 7). Attention should also be paid to the position of the retractors when retracting the buccal flap to prevent “crushing” injuries of the infraorbital nerve.

Subperiosteal Infections

The zygoma implant is quad-cortically stabilized with the drills traveling through the sinus and perforating the lateral aspect of the zygoma bone (Fig 8). During the travel of the drill in the trajectory of the osteotomy,



Fig 6 MRI shows the apical portion of the implant in the middle cranial base.

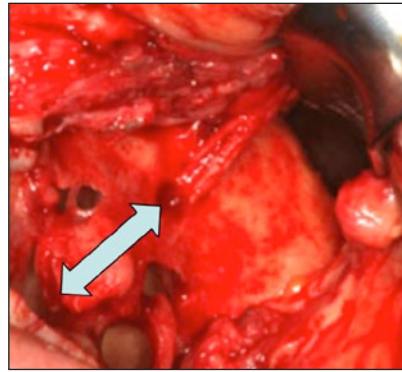


Fig 7 Limited distance between the crest of the maxilla and the infraorbital nerve.

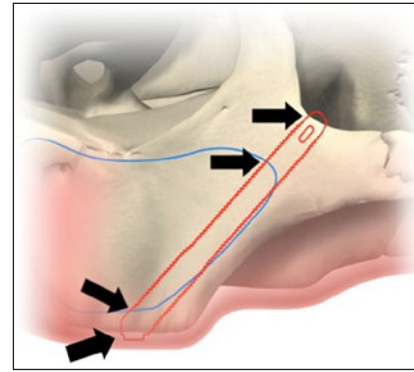


Fig 8 Schematic demonstrating the “quad-cortical” stabilization of the zygoma implant.



Fig 9 (Left) Identification of a radiolucent lesion at the apex of the zygoma implant.



Fig 10 (Center) Postoperative scan of the zygoma implant after the apicoectomy.



Fig 11 (Right) 6 months postoperative evidence of radiolucency at the apex of the implant.

the potential exists for collecting debris from the sinus or from the residual alveolus as well as the body of the zygoma, with the potential of depositing the debris underneath the periosteum of the tissues covering the zygoma bone. Hence, upon removal of the retractor from the fronto-zygomatic notch area without irrigation, any debris left behind from the preparation of the osteotomy may become infected and require antibiotics as well as incision and drainage.

The first author has experienced and treated two subperiosteal infections presented as follows.

Clinical Case Report

A woman aged 18 years with Chediak-Higashi Syndrome was edentulated and treated with the zygoma concept in the maxillary arch and the “tilted concept” in the mandibular arch.¹³ Nine months post-surgical reconstruction, the patient developed a swelling over her left zygoma bone, which was warm and tender to palpation. A three-dimensional (3D) radiographic study demonstrated a radiolucent area at the apical portion of the zygoma implant (Fig 9). Two courses of oral antibiotics over a 1-month period did not resolve the symptoms. The decision to surgically explore the area and perform an intraoral incision and drainage was made.

After appropriate anesthesia, the maxillary prosthesis was removed; intraoral dissection exposing the anterior maxillary wall as well as the fronto-zygomatic notch was completed, allowing direct visual access to the lateral portion of the zygoma bone.

With copious irrigation, apicoectomy of the zygoma implant was completed and the granulation tissue curettaged (Fig 10). After copious irrigation, the surgical site was closed and the fixed prosthesis replaced. The patient was placed on oral antibiotics for 1 week, and within 10 days, the subperiosteal abscess resolved with no adverse effect to the existing implant, and the integrity of the soft tissues over the patient’s left cheek was maintained.

Case 2

A woman aged 65 years underwent treatment with the quad-zygoma concept, and a fixed provisional prosthesis was immediately loaded. Six months posttreatment, the patient presented with a soft tissue mass over the left zygoma implant. A 3D radiographic study showed a radiolucent defect at the apex of the maxillary right posterior zygoma implant (Fig 11). With the patient’s consent, local anesthesia was administered; an extraoral approach through a “crows-feet” incision allowed direct visualization of the implant apex.

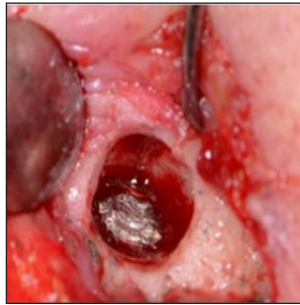


Fig 12 Removal of the apical portion of the implant.

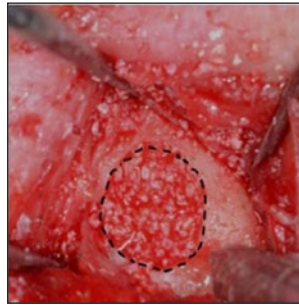


Fig 13 Grafting of the bony defect.

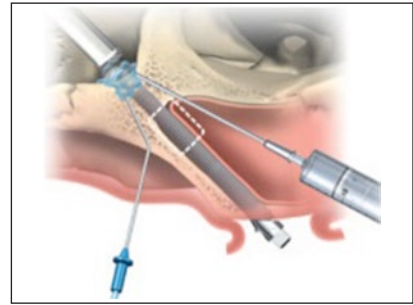


Fig 14 Copious irrigation of the fronto-zygomatic notch before removal of the retractor.

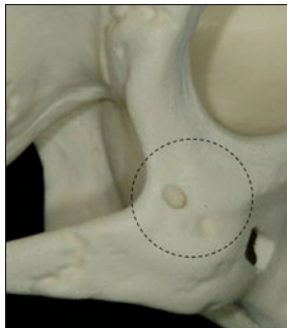
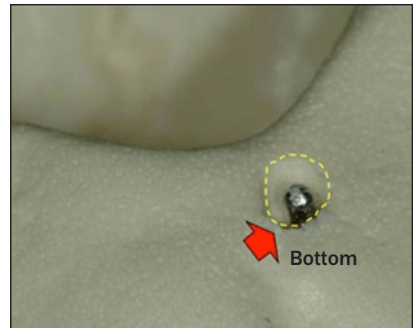


Fig 15 The buccal cortex of the zygoma bone is on a "slope".



Fig 16 The depth gauge can be oriented to measure from the top or the bottom of the apical osteotomy.



With copious irrigation, the apex of the implant was removed to leave the remaining portion of the resected implant with circumferential bony contact (Fig 12). The bony defect was irrigated and grafted primarily in an attempt to prevent the potential "dimple" formation over the surgical site (Fig 13).

The patient was placed on oral antibiotics for 1 week postoperatively, leading to resolution of the infection. All implants remained functional with the patient's ability to use her fixed prosthesis without interruption.

Solution and Clinical Management. As with all surgical techniques where preparation of an osteotomy is a part of the procedure with potential creation of debris particles, copious irrigation of the subperiosteal bony surfaces before the removal of the retractors and primary closure of the soft tissues is recommended⁹ (Fig 14).

Overextension of the Zygoma Implant Apex

The lateral cortex of the zygoma implant is on a "slope" (Fig 15); therefore, upon completion of the osteotomy, two optional measurements can be taken in order to determine the length of the zygoma implant to be used (Fig 16). Disorientation or the incorrect positioning of the depth gauge may lead to a shorter or

longer reading than the actual length of the prepared osteotomy.

If the overlying soft tissues of the patient's cheeks are thin, the overextended apical portion of the implant may be felt. In such cases, if the overextended portion of the implant creates discomfort for the patient, the tip of the zygoma implant may be removed after the osseointegration period (6 months) by performing an "apicoectomy" of the portion of the implant extending beyond the lateral cortex of the zygoma bone. The removal of the overextended tip of the implant can easily be accessed by an extraoral approach or through an intraoral vestibular incision. The use of a fissure carbide bur with copious irrigation can reliably separate the overextended apical portion. However, if a significant overextension is noted on the immediate postoperative ICAT study, it is advisable and practical to remove the implant immediately and replace it with a new shorter zygoma implant of the appropriate length before discharging the patient home.

The author has experienced two cases where apicoectomy was performed on the overextended portion of the implant and shortened to facilitate the normal topography over the lateral cortex of the zygoma implant.

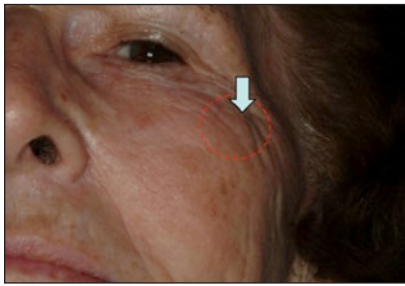


Fig 17 Prominence felt over the left cheek.

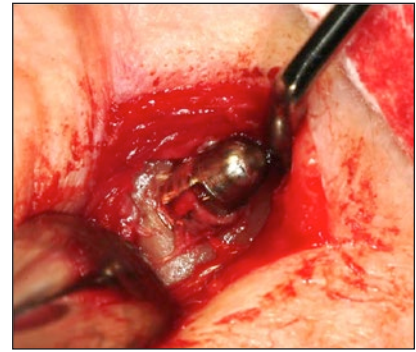
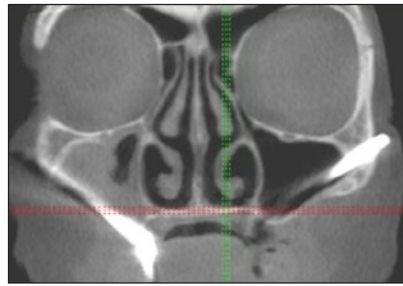


Fig 18 Extraoral exposure of the left zygoma implant apex.



Fig 19 Patient complained of a prominence felt over the left cheek at her 2-year follow-up.

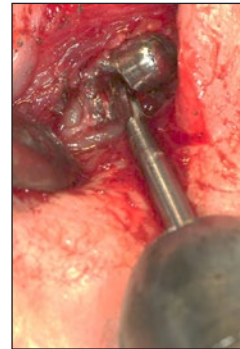
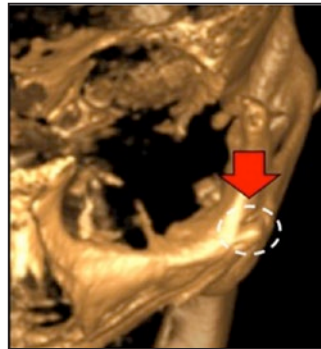


Fig 20 Exposure and removal of the apical portion of the implant.

Clinical Case Report

A woman aged 85 years had two anterior axial implants and two posterior zygoma implants placed. At the 6-month follow-up appointment, she mentioned that she could feel a prominence over the left maxilla (Fig 17). After description of the cause for the prominence, the patient consented to extraoral removal of the 3-mm overextended portion of the left zygoma implant. After administration of local anesthesia, an extraoral approach to expose the apical portion of the left zygoma implant was performed (Fig 18). With copious irrigation, the overextended portion was removed, and the lateral aspect of the zygoma bone was in complete contact with the remaining apical portion of the zygoma implant.

A layered closure of the overlying soft tissues was accomplished, and the patient recovered with no complications.

Clinical Case Report

A woman aged 79 years was treated with the quad zygoma concept for the maxilla and the tilted concept for the mandible. On her 2-year routine follow-up appointment, she requested if the prominence over her left cheek area could be addressed (Fig 19). Under local anesthesia, the tip of the overextended zygoma

implant was exposed and removed with no further complications (Fig 20).

Solution and Clinical Management. Direct visualization of the lateral cortex of the zygoma bone allowing for clear view of the tip of the depth gauge is recommended. The two positions as shown by Fig 15 are acceptable, as the lateral cortex of the zygoma bone is oriented on a slant.

The “Cosmetic Zygoma Implant”

Nine months after placement and reconstruction of a failing subperiosteal implant with the zygoma concept, the patient presented with swelling over her left zygoma bone.

Augmentin 875 mg twice a day was prescribed to treat what was considered a localized infection potentially due to postoperative debris left subperiosteally after completion of the osteotomy. After a 2-week follow-up, the infection was not resolved. The antibiotic was changed to Clindamycin 300 mg three times a day for 10 days. The patient was seen on day 14 with a draining fistula over the left cheek (Fig 21).

Following application of local anesthesia and careful dissection of the fistula, a Proplast implant used for esthetic augmentation of the patient's zygomatic prominence was identified (Fig 22). A further critical



Fig 21 Fistula over the left cheek bone.



Fig 22 Proplast zygoma implant removed from the fistula.



Fig 23 Evidence of the Proplast implant as shown by the arrow.



Fig 24 Dehiscence of the vestibular soft tissues exposing the threads of the implant.

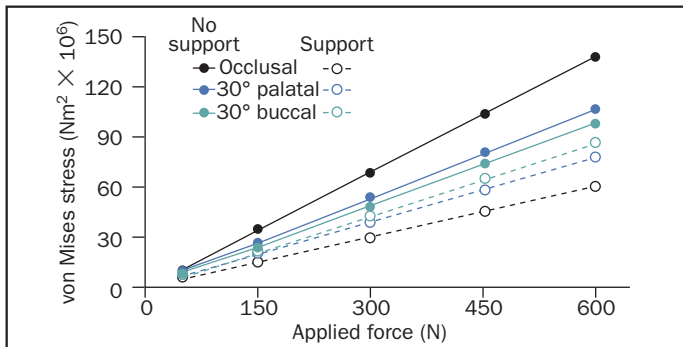


Fig 25 Higher occlusal loads are registered in cases with no crestal bone-to-implant contact of the zygoma implant.

review of the patient's 3D imaging showed the shadow of the Proplast implant over the left zygoma bone (Fig 23). After removal of the Proplast implant, the fistula resolved without further complications.

Solution and Clinical Management. To prevent potential complications when using the zygoma implant for patients with previous cosmetic augmentations, an in-depth interview of the patient as well as study of their preoperative 3D radiograph is recommended.

Vestibular Dehiscence

The potential exposure of the platform and threads of the zygoma implant placed in what is described as the "extrasinus" technique may present with maintenance concerns for patients and practitioners. Intraoral exposure of the platform and the threads of the implant is believed by the authors to be due to muscle pull on the unattached soft tissues of the vestibule causing irritation over the subperiosteal portion of the implant, leading to soft tissue dehiscence (Fig 24). Many "coverage procedures" including advancement flaps, buccal fat pad, and Alloderm have been used to cover the thread exposures with minimal success.

Solution and Clinical Management. When preparing the osteotomy for the placement of the zygoma

implant, the ad-modum Brånemark technique is recommended, which allows anchorage of the implant platform at the alveolar crest with the midportion of the implant within the maxillary sinus and immediately adjacent to the internal portion of the lateral maxillary wall. Having anchorage at the platform of the zygoma implant results in soft tissue adaptation to the underlying bone as well as better occlusal force distribution (Fig 25).

However, in cases where the lateral maxillary wall is grossly concave, ZAGA 4 morphology, or a maxillectomy has been performed, the platform of the implant and the threads will be subperiosteal and not supported by bone. In such clinical presentations, the potential dehiscence of the implant is not preventable, and preoperative patient education as to the potential for the exposure of the implant threads and the need for enhanced hygiene techniques is advisable.

Failed Zygoma Implant

Chrcanov and Abreu, in their 2013 systematic review of the zygoma implant, reported that the majority of the failures of zygoma implants occur during the 6-month osseointegration phase.⁵ Whether the immediately loaded zygoma implant fails during the osseointegration period or years after the delivery of the

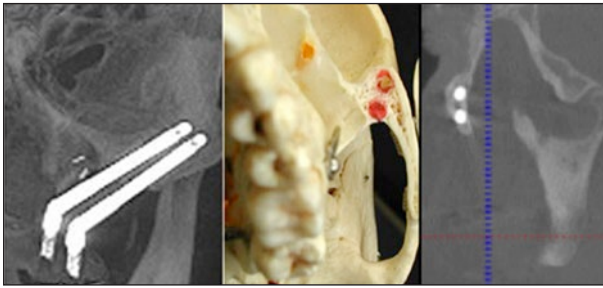


Fig 26 The top implant has its platform in the premaxillary crest and the bottom implant in the posterior maxillary crest.

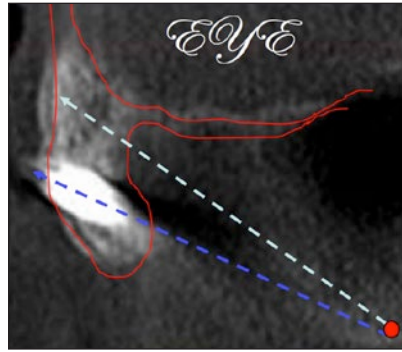


Fig 27 Mapping of the replacement zygoma implant.

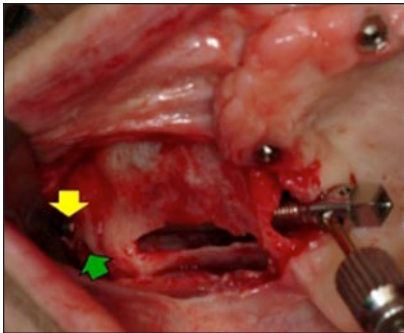


Fig 28 (Left) The replacement implant is placed through the existing opening of the maxillary crest.



Fig 29 (Right) Temporary titanium cylinder is used to incorporate the new zygoma implant into the prosthesis.

definitive prosthesis, a protocol for the management of the failed implant is prudent.

Two options may be considered if a zygoma implant has failed; the first option is to remove the failed implant with delayed placement with a new zygoma implant; the second option is the removal of the failed implant with immediate placement with a new zygoma implant.

If the first option is considered, the patient's fixed prosthesis would also be removed, with the delivery of a full conventional maxillary denture for the 3 months of healing time allowed for the failed site before placement of a new zygoma implant.

If the immediate replacement option is considered, the continuous use of a fixed prosthesis would be possible. In order to immediately replace the failed zygoma implant, it is important for the surgeons to understand the anatomy and the relationship of the "double zygoma" implant within the body of the zygoma bone.

When placing two zygoma implants within the same zygoma bone, the implants are placed "on top of each other" (Fig 26). The "top" implant will have its platform in the premaxilla directly below the lateral nasal aperture, while the "lower" implant will have its platform in the second premolar–first molar area of the posterior maxillary alveolus.

Solution and Clinical Management. When a zygoma implant is identified as failed, the immediate replacement option is considered by evaluation of the 3D imaging of the failed implant with identification of the available bony volume above the existing failed implant's apex (Fig 27).

The failed implant is removed, and the new implant is placed through the existing maxillary crestal position with a more medial trajectory of the drills preparing the apical osteotomy in the "top" position (Fig 28).

Once the new implant is placed, its platform is incorporated in the existing provisional prosthesis using a temporary titanium cylinder (Fig 29). In cases of delayed implant failure, which may be years after the delivery of the definitive prosthesis, a full complete denture is fabricated prior to removal of the failed implant and is then converted to an immediately loaded provisional following the same protocol as the original discussed "immediate loading concept."¹⁴

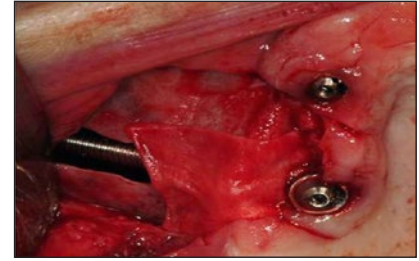
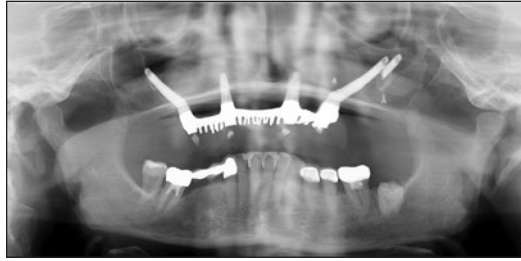
Six additional months for osseointegration is allowed for the new replacement implant prior to fabrication of the definitive prosthesis.

Fractured Implant

The author has treated five fractured zygoma implants in the past 18 years. In personal correspondence with other clinicians who use the zygoma implant on a

Fig 30 (Left) Apical portion of the sectioned zygoma implant adjacent to the replacement implant.

Fig 31 (Right) A resorbable membrane is placed to prevent oral antral fistula formation.



regular basis and have experience with fractured zygoma implants, the “loss” of cross-arch splinting is the most common clinical finding in patients who present with fractured zygoma implants.

As described by Ujigawa et al,¹⁵ in the unsplinted zygoma implants, there are significant forces at the implant platform and the prosthesis, both in centric loading and especially in lateral excursions. It should be emphasized that in splinted cases, the stress in lateral loading is minimal. Therefore, the importance of cross-arch splinting and maintaining the cross-arch splinting must be adopted by all clinicians. Patients must be educated on the importance of reporting any perception of movement in their fixed prosthesis. Clinicians are recommended to treat reports of movement as a priority and see the patient the same day to examine both the integrity of the prosthetic as well as the abutment screws.

It is crucial for the clinicians to understand that the “maintenance” of cross-arch splinting by periodic checking of the prosthetic screws as well as the abutment screws is extremely important for the long-term survival of the implants and the prosthesis. Depending on the occlusal habits of the patient, a pragmatic follow-up schedule of quarterly or biannual appointments is recommended for checking the stability of the prosthetic and abutment screws as well as cleaning of the prosthesis and examination of the peri-abutment soft tissues.

There are two options for the management of fractured zygoma implants.

The first option is to section the fractured zygoma implant at the base of the zygoma bone, leaving the apical portion of the osseointegrated implant within the body of the zygoma (Fig 30). The new zygoma implant is simultaneously placed following the same protocol as described for management of failed zygoma implants.

The second option is to remove the fractured zygoma implants and replace with a new implant immediately or 3 months later. The author has removed only one fractured zygoma implant. It is important to understand that these implants are osseointegrated at their apical portion, and extreme caution and patience in turning the implant in a counterclockwise direction

in an attempt to “disengage” the implant from the zygoma bone is prudent.

Solution and Clinical Management.

- The “mapping” of the intended path of the new zygoma implant using a 3D study is critical as seen in Fig 27.
- In cases where there is a large maxillary crestal bony defect, a resorbable membrane barrier should be placed over the platform of the implant in order to provide support for the overlying soft tissue closure (Fig 31). With the presence of the membrane, if the suture line was to break down prematurely, the incidence of oral-antral communication is limited or eliminated by having an underlying membrane barrier in place.

Sinus Infections

Lack of documentation of the incidence and/or the coloration between placement of the zygoma implant and sinus disease is apparent. Very few articles have briefly addressed the relationship of the zygoma implant and the reaction of the maxillary sinus tissues. Petruson, in 2004,¹⁶ reported on the reaction of the maxillary sinus to the zygoma implants placed by Brånemark. The conclusion from his study using an endoscope and visualizing the relationship of the sinus membrane to the existing zygoma implant was: “... there seems to be no increased inflammatory reactions in the normal nasal and maxillary mucosa in regions where titanium implants pass through the mucosa...”

In 2008, Davó et al¹⁷ reported on their experience with the placement of the zygoma implant and the incidence of sinus disease. They stated that sinuses penetrated by zygomatic implants seem to maintain a normal physiology. However, in approximately 15% to 20% of patients, early radiologic findings of hypertrophy of the sinus membrane without clinical symptoms were observed.

In 2006, Jung et al¹⁸ reported that sinus reaction to implants penetrating the sinus cavity without sinus augmentation may cause sinus membrane thickening without the clinical signs of sinusitis.

Based on published reports, it appears that titanium implants do not act as a foreign body causing chronic

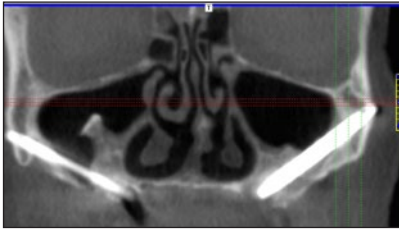


Fig 32 (Left) Titanium implants do not act as a foreign object within the maxillary sinus.

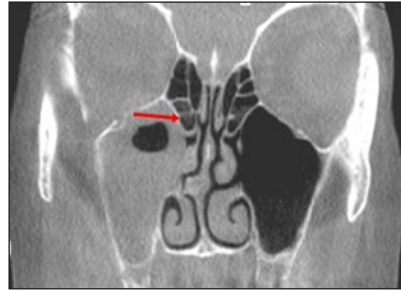


Fig 33 (Right) Isolated, right maxillary sinus infection.

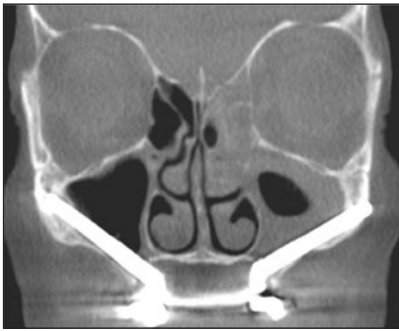


Fig 34 (Left) Left pan sinusitis involving the maxillary, ethmoid, and frontal sinuses.

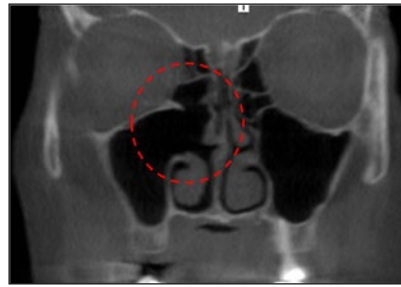


Fig 35 (Right) Post functional endoscopic sinus surgery (FESS) removing the uncinate process, the middle turbinate, and unroofing of the ethmoid air cells on the affected side.

sinusitis when they protrude or transverse the maxillary sinus (Fig 32).

In 2005, Becktor et al¹⁹ discussed the source for sinus infections as being the potential presence of oral-antral communication at the implant platform introducing bacteria into the maxillary sinus and not the presence of titanium within the sinus.

In 2010, Stiévenart and Malevez²⁰ reconfirmed Becktor's conclusion that the migration of bacteria from the oral cavity through oral-antral communications is the cause for the presence of maxillary sinus infections.

Gwaltney et al, in their 1996 publication in the *Clinical Infectious Disease* journal entitled, "Acute community acquired sinusitis" reported that historically, it is believed that the maxillary sinus is sterile and not colonized by any bacteria. The presence and the dynamic nature of the ciliated sinus mucosa prevent significant colonization of bacteria within the maxillary sinus. However, if the ostiomeatal complex (OMC) is blocked, resultant mucosal hyperplasia or hypertrophy with production and collection of mucous produced by the secretory cells of the sinus membrane in the presence of bacterial overgrowth may produce sinus infections.

Clinicians must be aware that reoccurrence of sinus disease in spite of chemotherapy is due to physiologic blockage of the OMC in patients who otherwise do not have a history of sinus disease or compromised immune system.

Postsurgical debris left inside the maxillary sinus can migrate and block the OMC and may also contribute to the postsurgical maxillary sinus infections.³

The author has experienced nine incidences of re-occurring sinus infections, and they have all been identified as unilateral, which is consistent with the reports of the zygoma implants and maxillary sinus infections in the literature.

In evaluation of patients with maxillary sinus infections, it is important to identify whether the infection is limited to the maxillary sinus (Fig 33) or involves the ethmoid, the frontal, as well as the sphenoid sinuses (Fig 34). The potential for pan sinusitis should also be considered and ruled out when evaluating the 3D scans of patients with maxillary sinus infections.

Patients may present with all or a few of the signs and symptoms. The signs and symptoms of sinus infections include pressure, pain, fullness, potential facial swelling, potential facial erythema, malaise, fever, drainage, or foul-smelling mucopurulent material into nasopharynx or nasal cavity. It is advisable for clinicians operating in the maxillary sinus to be aware of the skills needed to identify isolated or pan sinusitis patients whether they intend to treat or refer the patients for treatment.

Solution and Clinical Management. The generally accepted initial treatment of the patient presenting with signs and symptoms of sinus infections include:

- Humidification of the inspired air that may aid in loosening of the dried secretions at the ostium
- To facilitate drainage, systemic decongestants, Sudafed, nasal spray, 2% ephedrine, or 0.25% phenylephrine may be considered.
- Antibiotic treatment including Amoxicillin, Augmentin, Bactrim/Septtra DS, Zinacef, or Levaquin may be considered.

In patients with suspected sinus infections, it is absolutely crucial to refer these patients to practitioners familiar with treatment of sinus infections if the clinician is not familiar and does not have experience in treating sinus infections.

With reoccurrence and in cases where resolution with chemotherapy is not achieved, performance of a functional endoscopic sinus surgery (FESS; Fig 35) by the otolaryngologist to reestablish patency of the OMC and therefore drainage of the involved maxillary and ethmoid sinuses is recommended.³

DISCUSSION

The zygoma implant is a means to establish posterior support in patients who lack remaining alveolar bone in Zones 2 and 3 by engaging a distal bone site. It is a predictable implant whether used as the primary implant or as the "Rescue" implant in reconstruction of the atrophic maxilla.

Understanding the proper protocol for the placement of the implant is critical. Appreciation that this procedure is "complex" and should be performed by experienced surgeons with training in the maxillofacial region is crucial in limiting the potential complications and managing associated complications when using the zygoma implant.

The experienced surgeon should be aware of the various recommendations for the prevention as well as the treatment of potential complications with this treatment protocol.

CONCLUSIONS

A comprehensive knowledge of the specific steps for the proper execution of this complex procedure is critical for a predictable outcome. Understanding the cause, the prevention, as well as the management of potential complications is imperative for the contemporary surgeon using the zygoma implant.

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REFERENCES

1. Bedrossian E, Rangert B, Stumpel L, Indresano T. Immediate function with the zygomatic implant: A graftless solution for the patient with mild to advanced atrophy of the maxilla. *Int J Oral Maxillofac Implants* 2006;21:937–942.
2. Brånemark PI, Hansson B, Adell R, et al. Osseointegrated implants in the treatment of the edentulous jaw. Experience from a 10-year period. *Scand J Plast Reconstr Surg Suppl* 1977;16:1–132.
3. Bedrossian E. Rehabilitation of the edentulous maxilla with the zygoma concept: A 7-year prospective study. *Int J Oral Maxillofac Implants* 2010;25:1213–1221.
4. Aparicio C, Manresa C, Francisco K, et al. The long-term use of zygomatic implants: A 10-year clinical and radiographic report. *Clin Implant Dent Relat Res* 2014;16:447–459. Epub 2012 Oct 18.
5. Chrcanovic BR, Abreu MH. Survival and complications of zygomatic implants: A systematic review. *Oral Maxillofac Surg* 2013;17:81–93.
6. Goiato MC, Pellizzer EP, Moreno A, et al. Implants in the zygomatic bone for maxillary prosthetic rehabilitation: A systematic review. *Int J Oral Maxillofac Surg* 2014;43:748–757.
7. Bedrossian E, Brånemark PI. *Fonseca Oral & Maxillofacial Surgery, Second Edition, Volume 1*. Philadelphia: Saunders, Elsevier: 491–500.
8. Bedrossian E, Bedrossian EA, Brånemark PI. *Fonseca Oral & Maxillofacial Surgery, Third Edition, Volume 1, PP*. Philadelphia: Saunders, Elsevier: 569–583.
9. Brånemark System Zygoma; Procedural Manual. Nobel Biocare Services AG, 2014: 23–35.
10. Cikatricis P, Salvi SM, Burke JP. Iatrogenic lateral rectus transection secondary to dental implantation surgery. *Orbit* 2008;27:305–307.
11. Reyhler H, Olszewski R. Intracerebral penetration of a zygomatic dental implant and consequent therapeutic dilemmas: Case report. *Int J Oral Maxillofac Implants* 2010;25:416–418.
12. Macedo VC, Cabrini RR, Faig-Leite H. Infraorbital foramen location in dry human skulls. *Braz J Morphol Sci* 2009;26:35–38.
13. Alzoubi F, Bedrossian E, Wong A. Oral rehabilitation of patients with Chediak-Higashi syndrome using zygoma and root form implant-supported fixed prostheses: A report of two patients. *J Prosthet Dent* 2016;116:831–835.
14. Bedrossian E. Rescue implant concept: The expanded use of the zygoma implant in the graftless solutions. *Oral Maxillofac Surg Clin North Am* 2011;23:257–276.
15. Ujigawa K, Kato Y, Kizu Y, Tonogi M, Yamane GY. Three-dimensional finite elemental analysis of zygomatic implants in craniofacial structures. *Int J Oral Maxillofac Surg* 2007;36:620–625.
16. Petruson B. Sinoscopy in patients with titanium implants in the nose and sinuses. *Scand J Reconstr Surg Hand Surg* 2004;38:86–93.
17. Davó R, Malevez C, López-Orellana C, Pastor-Beviá F, Rojas J. Sinus reactions to immediately loaded zygoma implants: A clinical and radiographical study. *Eur J Oral Implantol* 2008;1:53–60.
18. Jung JH, Choi BH, Zhu SJ, et al. The effects of exposing dental implants to the maxillary sinus cavity on sinus complications. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod* 2006;102:602–605.
19. Becktor JP, Isaksson S, Abrahamsson P, Sennerby L. Evaluation of 31 zygomatic implants and 74 regular dental implants used in 16 patients for prosthetic reconstruction of the atrophic maxilla with cross-arch fixed bridges. *Clin Implant Dent Relat Res* 2005;7:159–165.
20. Stievenart M, Malevez C. Rehabilitation of totally atrophied maxilla by means of four zygomatic implants and fixed prosthesis: A 6–40 month follow-up. *Int J Oral Maxillofac Surg* 2010;39:358–363.