Endoscopically-Assisted Zygomatic Implant Placement: A Novel Approach

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Abstract

Background Zygomatic implants (ZIs) have been proposed as a valid alternative to advance bone-grafting procedures in the rehabilitation of the severe atrophied upper maxilla, with a reported overall success rate of more than 95 %. Otherwise, the use of the endoscope has been described for the treatment of maxillofacial trauma, orthognathic surgical procedures, sinonasal pathology, salivary gland disease, and TMJ internal derangement. A careful identification of anatomical landmarks is of utmost importance while trying to avoid potential complications during the insertion of ZIs. Several approaches for ZI insertion have been reported, such as the classical approach; the sinus slot technique; and the exteriorized approach.

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Materials and Methods The authors first introduce in the literature the endoscopically-assisted approach for the insertion of ZIs in the extremely severe atrophic maxilla.

Results Optimal results in terms of ZIs positioning with no damage to surrounding structures were obtained.

Conclusions By means of this new technique the surgeon may minimize the risk of complications related to the damage of neighbouring anatomic structures, such as orbital disruption or infraorbital nerve damage, while ensuring an adequate drill positioning and angulation for the placement of one or two implants into the zygomatic bone.

Keywords Zygomatic implants · Endoscopically-assisted approach · Severe atrophic maxilla · Zygomatic bone · Complications

Introduction

The endoscopic-assisted approach has been described for the reduction of several fractures within the maxillofacial skeleton, such as those in the orbit, frontal sinus, zygomatic arc and mandibular condyle [1–4]. Previously, a wide experience with the use of the endoscope has been reported by performing arthroscopy for the treatment of internal derangement of the temporomandibular joint (TMJ) [5]. Also, the routine using of the endoscope by ear, nose and throat (ENT) surgeons for diagnostic and therapeutic purposes within the upper airway and para-nasal sinuses has aimed maxillofacial surgeons to extend its use for other applications within the facial skeleton, such as for the osteotomies performed in orthognathic surgical procedures [6–8].

In the arena of oral rehabilitation, zygomatic implants (ZIs) have been proposed as a valid alternative to advance bone-grafting procedures for the functional rehabilitation of

the severe atrophied maxilla. These are aimed to be placed through the maxillary sinus from the alveolar process up to the zygomatic bone, achieving stability [9]. In 2011, Aparicio [10] proposed a classification system for categorizing zygomatic implant (ZI) cases for therapy planning, which he called *zygoma anatomy guided approach* (ZAGA). By this system, he identified five skeletal forms of the zygomatic buttress-alveolar crest complex and subsequent pathways of the zygomatic body (ZB). This approach might be useful to guide the surgeon through the insertion of the ZI from a wide exposition of the alveolar bone and zygomatic process in order to completely visualize the start and end point for implant insertion.

Accordingly, a careful identification of anatomical landmarks must be of utmost importance while trying to avoid potential complications during the insertion of ZIs, such as orbital disruption, infraorbital nerve damage, malposition of implants or protrusion of the ZIs through the malar bone. While the classical approach is mainly based on the external morphology of the maxillary alveolar process and the curvature of anterior maxillary sinus wall, a wide exposition of the upper maxilla and zygomatic bone is necessary.

The use of the endoscope may assist the surgeon in better controlling the sites of insertion of ZIs within the maxillary sinus, and also in assessing the emergence of implants at the external cortex of the malar bone. In the present report, we present which is to our knowledge the first clinical case on the use of the endoscope to assist the insertion of ZIs.

Case Report

A 56-year-old totally edentulous woman with an extremely severe atrophied maxilla presented to our institution for evaluation of dental implant rehabilitation. No history of smoking habit, bisphosphonate intake or bone metabolic disease was registered. Panoramic radiography and cone-beam computed tomography (CBCT) were performed to evaluate the degree of bone reabsorption of the maxilla. A severe reabsorption of the anterior maxillary bone together with a large pneumatization of the posterior maxilla, with residual height <5 mm was demonstrated bilaterally. The patient refused to undergo bone grafting prior to implant placement, thus sinus lift procedures and onlay bone grafting of the anterior maxilla were obviated and two zygomatic implants were offered bilaterally for the rehabilitation of the complete upper maxilla. Surgery under general anaesthesia and nasotracheal intubation underwent uneventfully and the patient was discharged under oral antibiotics and non-steroid anti-inflammatory drugs (NSAIDs) 1 day post-operatively. Post-operative panoramic radiography showed the adequate placement of four zygomatic implants (Fig. 1).

Fig. 1 Post-operative panoramic radiography of the patient with four zygomatic implants in place

Technical Note

Surgical access begins with the incision to get access into the alveolar crest, from one maxillary tuberosity to the contralateral one, with two vertical releasing incisions at the most posterior extents of the crestal one. Subsequently, a subperiosteal dissection is carried out, exposing the alveolar crest and the hard palate. Dissection continues along the entire anterior and lateral maxillary bone, till the zygomatic bone is reached, clearly identifying the exit of the infraorbital nerve through the infraorbital foramen at the upper area of the maxillary bone. The zygomatic body (ZB) is then exposed completely, while identification of the inferior and lateral orbital rim is performed and the anterior part of the zygomatic arc clearly freed from the overlying soft tissue. An inverted Langenbeck retractor placed subperiosteally is useful to lift the soft tissue around the zygomatic bone and to allow a direct visualization of the most lateral aspect of the malar bone. According to the classical description by Brånemark for the insertion of ZIs [11], a 1-cm antrostomy is performed in the lateral aspect of the maxillary sinus wall with a round bur, and further gross retraction of the Schneiderian membrane is performed, although membrane perforation or disruption does not constitute a problem.

A 4-mm 30° rigid endoscope is introduced through the most anterior side of the antrostomy and carefully advanced to the upper wall of the maxillary sinus. Intranasal irrigation with ringer lactate serum allowed us to clean the optic debris intranasal clots. Once the upper wall of the sinus is identified, the endoscope is turned medially so that the tip of the endoscope could sweep the cavity to visualize the uppermost lateral aspect of the maxillary sinus, which constitutes a narrow concavity. Then, the assistant surgeon manually holds the endoscope, while the main surgeon introduces the first round bur through the alveolar crest from its palatal side. At this moment, the bur is visualized through the antrostomy and it

is advanced up to the body of the zygomatic process. With a direct visualization through the endoscope, the bur marks the entrance at the body of the zygoma. This site must be located in the uppermost lateral point of the cavity, from an intrasinus endoscopic point of view. Later, the alveolar process and the entire site in the zygoma are perforated with a Ø2.9-mm twist drill. In the endoscopic view, the twist drill must be introduced through the marked point at the sinus concavity in the ZB. In the macroscopic view, the projection of the twist drill must point at the most lateral aspect of the ZB, with the exit inferior and laterally to the lateral orbital rim and anteriorly to the zygomatic arc. Once the exit of the drill is performed, the endoscope is removed from the sinus cavity and introduced externally to the ZB to visualize the hole in the bone corresponding to the exit of the drill. Retraction of the soft tissue with the Langenbeck retractor may allow enough space for direct visualization and also ensures an adequate endoscopic view. Once the hole is visualized, the endoscope is introduced again in the maxillary sinus to control the entrance in the ZB. Afterwards, a Ø3.5-mm twist drill is inserted through the alveolar process up to the ZB, with direct visualization through the endoscope. After the hole is performed at the ZB, a depth probe is inserted to check the length of the site. Later on, the ZI with the appropriate length is slowly inserted through the alveolar bone until the apex has reached the ZB intrasinusally. Under endoscopic view the ZI is introduced through the hole in the ZB (Fig. 2), and then implant insertion is performed manually, until the implant apex reaches the outer cortex of the malar bone. The exit of the apex of the ZI can be checked by the endoscope placed laterally to the zygomatic bone (Fig. 3). Mucoperiosteal flaps are finally closed with the palatal flaps at the crestal alveolar incision. See the video for proper visualization of the technique.

Fig. 2 Intrasinus endoscopic view of a second zygomatic implant inserting in parallel to the first one into the zygomatic body

Fig. 3 Extrasinus endoscopic view of the lateral side of the zygomatic bone showing the emergence of two zygomatic implants through the outer cortex of the malar bone

Discussion

ZIs have been proposed for oral rehabilitation in several clinical scenarios, such as ablative tumor surgical defects, trauma sequelae, congenital defects, gunshot wounds, and in most of the cases, for the management of the atrophic upper maxilla. The concept of this treatment modality was first developed to obtain anchorage and consequent stability in the zygomatic bone by the use of longer implants (>30 mm) and the placement of 2–4 standard implants in the anterior area to increase prosthesis support. In the past decades, this alternative to bone-grafting procedures has shown its predictability by demonstrating high survival rate (>95 % over a medium-/long-term follow-up) and few technical and biologic complications to bone grafting approaches in posterior maxilla and thus, its application in the routine rehabilitation for patients with severe atrophic maxilla [12–14].

Several approaches for ZI insertion have been reported, such as the classical approach (known as Brånemark approach) [11] the sinus slot technique [15] and the exteriorized approach [16]. By the first two modalities, an osteotomy is performed at the lateral aspect of the sinus wall to get access into the sinus cavity. Consequently, the ZI is directly visualized while progressing through the sinus cavity up to the ZB. On the other hand, by the exteriorized approach, the ZI is inserted outside the sinus cavity, and no antrostomy is performed. A comprehensive description of all the above reported approaches have been reviewed in a recent study by Chrcanovic et al. [17]. These authors reported that when the maxillary alveolar process is severely resorbed, then the concavity of the anterior-lateral maxillary wall is expected to be small, and hence, the classical or the sinus slot approaches should be carried out. However, when the maxillary bone has a pronounced concavity, the exteriorized approach is oftentimes

preferable. While the classical approach offers a wide visualization of the upper wall of the sinus, the sinus slot technique enables a more vertical implant angulation, bringing the head of the implant more buccally at the alveolar crest, although visualization of the base of the ZB may not be the most adequate. The use of the endoscopically-assisted approach is achievable when ZIs can be inserted through the maxillary sinus, while it is not actually useful for the exteriorized approach in scenarios of maxillary bones with a pronounced concavity. If the classical approach is carried out, then the 1-cm antrostomy is used to introduce the endoscope. In those cases in which the sinus slot technique is performed, an additional 0.5-cm hole must be implemented in the maxillary sinus lateral wall in a more anterior position.

Biomechanical models by three dimensional finite element analyses have shown that stress, due to occlusal forces, is mainly supported by the zygomatic bone, while it is not significantly influenced by the anatomical structure of the upper maxilla [18]. This concept is particularly relevant regarding transmission of forces exerted from the fixed prosthesis, since stress is not concentrated in the atrophied alveolar process of the maxilla. Additionally, biomechanical studies give support to the exteriorized approach. As the zygomatic bone is essential for placing ZIs, the angulation of these and also the entrance point at the ZB from the sinus have to be adequately landmarked and performed. This represents a challenging situation for the sinus slot technique and also in cases when two ZIs implants are inserted through a single maxillary sinus. In these scenarios, the use of the endoscope may assist/guide the surgeon to better parallelize both ZIs and to avoid any potential vector conflict while introducing both implants through the zygomatic bone. Furthermore, the vector of the twist drill corresponding to the second ZI must be compared with that corresponding to the already inserted first ZI, to achieve the best parallelism between both ZIs.

Wang et al. [19], in a recent systematic review, observed a zygomatic implant survival rate weighted mean of 96.7 %, with a 95 % confidence interval of 92.5–98.5 %, and reported orbital perforation to be the most significant complication, despite being infrequent. Davó and Pons [20] have reported several complications for ZIs supported-fixed prostheses, such as penetration of the orbital cavity during the drilling protocol, infection following fistula, sinusitis, fracture of the abutment screw and fracture of the prosthesis. Moreover, Kahnberg et al. [21] cautioned that if additional ZIs implants are needed, the anterior ZIs might involve the wall of the orbit. Other reported complications were soft tissue infection, paresthesia and oroantral fistulae. With the aid of the endoscope, the floor of the orbit could be clearly identified, thus avoiding any potential entrance in the orbital cavity while drilling. Consequently,

it also alleviates the risk of paresthesia following disruption of the infraorbital nerve.

Any possible intrasinus bleeding may be identified early and controlled, while mucosal debris may be extracted to avoid potential post-operative infections. Once one or two ZIs have been properly inserted, the anatomy of the MS may be fully visualized to control the permeability of the sinonasal foramen, hence preventing, by a meotomy, any potential sinusitis due to the absence of sinus permeability. As the endoscope is introduced laterally to the malar bone at the end of the procedure, the apex of the ZI is visualized anchoring to the outer cortex of the zygomatic bone. Through the endoscope, the surgeon may firmly ascertain that the apex of the ZI is at the level of the cortex and does not grossly trespass the surface of the malar bone, thus decreasing the risk of foreign body reaction or inflammation of the overlying soft tissue. Finally, as asserted by Schubert and Jenabzadeh [22] for maxillofacial trauma, the endoscope allows other surgeons in the operating theatre to closely visualize what is going on, and also to videotape the procedure. This is also applicable to the procedure of ZIs insertion for the treatment of the severe atrophied maxilla.

Conclusion

The endoscopic-assisted approach for the insertion of ZIs makes more reliable the treatment by minimizing the risk of complications related to neighbouring anatomic structures such as the orbit or the infraorbital nerve. It also ensures an adequate drill angulation for the placement of one or two implants into the zygomatic bone. Further clinical trials are necessary to consolidate this technique.

Compliance with Ethical Standards

Conflict of interest None.

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