Zygomatic Implants for the Rehabilitation of Atrophic Maxillae: A Retrospective Study on Survival Rate and Biologic Complications of 206 Implants with a Minimum Follow-up of 1 Year

Perla Della Nave, DDS[1]/Alberto Vericat Queralt, MS[2]

Purpose: To carry out a retrospective analysis of the placement of zygomatic implants in atrophic maxillae and to assess the outcomes in terms of survival rate and biologic complication incidence, with a follow-up of at least 1 year and in 13% of cases, longer than 5 years. ***Materials and Methods:*** The study included all patients rehabilitated through zygomatic implant surgery from 2006 to 2017 and excluded those treated in 2018 to guarantee a minimum follow-up of 1 year. Depending on the specific case, one, two, or three zygomatic implants were placed in combination with conventional implants, or four zygomatic implants were placed alone (zygoma quad). All implants were placed by the same surgeon in a private clinic through an anatomy-guided surgical approach and were immediately loaded with screwed provisional prostheses up to the end of the osseointegration phase. Patients who did not undergo any or the last follow-up visits were not included in order to assess the real conditions of implants, soft tissues, and maxillary sinuses in the last year of follow-up (2018). ***Results:*** A total of 206 zygomatic implants were placed in 102 patients. There were only two failures due to a lack of osseointegration (0.97%): in one case, 3 months after placement and in the other one, 2 years after placement. There were five cases of sinusitis (2.42%), two of which also presented oroantral communication (0.97%); in three cases, antibiotic and conservative treatments alone were not effective, so the removal of the zygomatic implant was necessary. Finally, two cases of mucosal recession (0.97%) appeared in two anterior zygomatic implants. The global survival rate was 97.57%, and all biologic complications are currently stable. ***Conclusion:*** In this study, the rehabilitation of atrophic maxillae through zygomatic implants was shown to be a predictable treatment, which allows a graftless approach and makes it possible to carry out immediate loading protocols, with enormous psychologic advantages for patients. Survival rates are high, and complication incidence is low. Thus, at present, zygomatic implants may be considered a reliable treatment option in the case of severe atrophic maxillae. *Int J Oral Maxillofac Implants 2020;35:1177–1186. doi: 10.11607/jomi.8448*

Keywords: atrophic maxilla, complications, immediate loading, survival rate, zygomatic implants

The atrophic maxilla often constitutes a challenge for oral surgeons and prosthodontists, especially in the most severe cases. Indeed, it not only imposes consistent limitations to conventional implant placement but also complicates rehabilitation with efficient, retentive, and comfortable removable dentures, due to the lack of favorable anatomical structures. For this reason, in totally edentulous patients who have been wearing complete removable dentures for many years after tooth loss or failure of bone grafts and/or implants, stability of such dentures is often extremely poor due to advanced bone resorption, flat palatine vault, and superficial muscular insertions.[1]

In cases of different degrees of bone deficiencies, various bone augmentation techniques do exist, for example, nasal floor grafting and maxillary sinus elevation, guided bone regeneration (GBR), block bone regeneration, Le Fort I technique combined with inlay or onlay grafts, horseshore grafts, distraction osteogenesis, and split crest technique. In most cases, it deals with sensitive[2,3] and not always predictable techniques,[4] often entailing several risks[3,4] and further disadvantages. They are invasive techniques with high biologic costs[5,6] and require a long treatment time,[1,2,5–11] two or more surgical interventions,[1,12–14] general anesthesia, and hospitalization.[12] They are also associated with high morbidity,[1,2,5–7,9–13] even in donor areas (for example,

[1]Private Practice, Madrid, Spain.
[2]Private Practice, Valencia, Spain.

Correspondence to: Perla Della Nave, Paseo de la Alameda 64-65 bajos, 46023, Valencia, Spain.
Email: pdellanave@vericatimplantologia.com

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iliac crest[5,7,12,15]), and several severe complications,[1,2,8] such as sinusitis,[2,5] bleeding,[2] pain,[5,16] graft exposure or contamination[3,5] sometimes leading to partial/total loss,[3,4] infections,[2] presence of insufficient bone after graft healing and integration phase,[5] neurosensory disorders, and gait disturbances.[2,5] It is noteworthy that the main inconvenience of this kind of regeneration technique may be the length of time that must pass[10,13,17] before implants can be placed for the definitive prosthetic restoration (sometimes even more than a year[12]), which clearly brings great functional, psychologic, and social discomforts to the patient.[17] Also, dentures are not indicated in the first weeks after the intervention.[18]

To overcome similar problems, several alternatives have been proposed. Although in cases of mild/moderate atrophy, short, tilted, or pterygoid implants or sinus elevations can be carried out, severe atrophies need another type of implant: the zygomatic implant. Zygomatic implants are long implants that have the peculiarity of relying on a remote anchorage, ie, the zygomatic process, which gives them optimal primary stability.

In comparison to the aforementioned regeneration techniques, zygomatic implants are a graftless approach and constitute a less invasive technique with an infinitely lower biologic cost. They allow for solving different degrees of maxillary atrophy without grafts[3,15,19] in much shorter times,[2,6,15,17,19] with only one surgery and surgical field, with local anesthesia (the most recent tendency is not to use general anesthesia), reducing risks,[20] morbidity,[6,17,20] the probability of complications, and the global complexity of the treatment.[2]

Another important use of zygomatic implants aims at the rehabilitation of patients who experienced failures of previously placed implants, even in association with advanced regeneration techniques, which, in many cases, leaves severe sequelae, such as enormous defects and significant iatrogenic atrophies. In addition, zygomatic implants have shown high survival rates, which can be compared (even favorably) with those of conventional implants.[21–23] Finally, the main advantage provided by the use of zygomatic implants may be the possibility of rehabilitating severe atrophies with no need for further grafts and with the possibility to apply immediate loading protocols.

Zygomatic implants were introduced by Brånemark in 1988[1] for the rehabilitation of patients after resective maxillectomies due to neoplastic pathologies, congenital defects, or traumatic accidents.[10,17,24–27] According to the original technique, the implant has an intrasinusal path[1,5,7,9,16,20,21,28,29] and an eminently palatal prosthetic emergence,[1,5,7,9,11,20,21,24,28,29] which is even more marked in patients with a lot of vestibular maxillary concavity[20,30] and causes discomfort to the patient in terms of phonetics and hygiene.[1,11,16,29,31] On the contrary, the sinus slot technique, introduced by Stella and Warner,[1,5,7,22,29,32,33] allows obtaining of a more favorable emergence of the implant.[7] The Zygomatic Anatomy-Guided Approach concept, described by Aparicio et al,[30] is a modification of the extrasinusal technique, and can be applied to very different maxillary anatomies. The entry point is crestal, the apical anchorage is in the zygoma bone, and the implant path depends on the degree of maxillary resorption.

The aim of the present study was the analysis of the survival rates and the incidence of biologic complications after the placement of zygomatic implants in a sample of patients after a follow-up of 1 to 12 years.

MATERIALS AND METHODS

In this retrospective study, all patients rehabilitated with zygomatic implants in the authors' private clinic from 2006 to 2017 were analyzed, with a follow-up range from 2006 to 2018.

In the surgical phase, all zygomatic implant surgeries were carried out by the same surgeon (A.V.), opening a window in the maxillary sinus and following the Zygomatic Anatomy-Guided Approach, in order to achieve an ideal and comfortable prosthetic emergence of the implants (from both the prosthetic and patient point of view). Two types of zygomatic implants were placed, intraoperatively chosen according to the specific case (among which no distinction will be made considering its relevance to the aim of the present analysis): rough (Brånemark System, Zygoma TiUnite) or smooth surface (Zigomático HE, Neodent, Instradent), with the latter being selected in cases of zygomatic bones of lower density and in the majority of extramaxillary paths in order to facilitate the management of mucus inflammation in case of recession. Trans-epithelial multiunit abutments were always placed on all implants, with the aim of moving the prosthetic connection away from the implant neck, improving the stability of the peri-implant biologic environment and facilitating prosthetic rehabilitation.

For the prosthetic phase, all patients underwent an immediate loading protocol, and resin provisional prostheses, with a metal framework reinforcement, were screwed. After osseointegration (3 months after the surgery), the definitive screwed prosthesis was made of a metal (chrome-cobalt) structure of stumps, lithium disilicate individual crowns, and a pink composite artificial gum with a correct and adequate design to facilitate the maintenance of good hygiene and minimize retentive areas, especially around multiunit connections. The passive fit was tested in the cast models while screwing the prostheses into patients' mouths to check the

absence of any kind of tension, and in case of doubt, through intraoral radiographs. In a few cases included in the study, after rejecting this type of prosthesis for economic reasons, patients continued to wear the provisional prosthesis after the healing phase, after relining them to compensate the gap after gingival healing and enriching the structure with further metal frameworks (normally, the laboratory prepares CAD/CAM-made cylinders with metal wings as a reinforcement).

The following inclusion criteria were established:

- All surgeries carried out between the beginning of 2006 and the end of 2017, to guarantee a minimum follow-up of 1 year (until 2018).
- Rehabilitations with one, two, or three zygomatic implants combined with conventional implants (eg, Fig 1).
- Rehabilitations with four zygomatic implants (zygoma quad; eg, Figs 2 to 5)
- Patients submitted to the majority and, at least, the last of the annual follow-up visits and maintenance programs (ie, the one in 2018).
- Patients were included independently from general conditions (eg, diabetes, hypertension, etc) or smoking habit.
- Patients were included independently from local conditions (periodontal disease, multiple implant failures, partial/total edentulism, type of antagonist, etc).

The following were the exclusion criteria:

- Surgeries carried out that were not in the preestablished period.
- Surgeries carried out in 2018, since they do not meet the criterion of at least 1 year of follow-up.
- Patients who did not attend any or the last of the follow-up visits (ie, the one in 2018).
- No patients were excluded according to general/local conditions.

It is important to note the protocol in annual visits in detail (in all patients and for any kind of implant rehabilitation). Prostheses were removed, and a thorough cleaning was carried out around the multiunit abutments, with titanium curettes, silicone cups, and antiseptic gels (chlorhexidine 0.20%). In addition, orthopantomography was performed to have a general perspective of patients' implants; periapical radiographs were carried out to evaluate the marginal bone loss of the conventional implants only, since this aspect is not crucial in the majority of zygomatic implants, which can also be extramaxillary. Nevertheless, in specific cases and/or if the patient referred to some kind of symptomatology, CBCT was performed to check the conditions of the maxillary sinus. A careful intraoral inspection was also performed: peri-implant soft tissue conditions were observed to evaluate the absence of inflammation and infection with suppuration and/or recession; all implants were percussed, and the torque of multiunit abutments was confirmed to make sure that no loss of part of the torque (something that would constitute a significant risk of screw fracture) had occurred; by confirming the torque of multiunit abutments, the absence of rotational mobility of all implants was also tested out, which would represent a clear sign of failure; finally, an extremely soft probing was carried out with a titanium probe to check the absence of peri-implant alterations. The conditions of the prostheses, abutments, and (both clinically and radiologically) peri-implant tissues were ascertained, as well as the absence of failures and biologic complications.

RESULTS

A total of 102 patients and 206 zygomatic implants were included in this retrospective study. In Table 1, the type of treatment and number of zygomatic implants placed are itemized; in Table 2, the number of patients along with the corresponding number of years of follow-up is also specified, which was globally from 1 up to 12 years, and in 13% of cases, it was longer than 5 years.

For the survival rates and the complications related to the 206 zygomatic implants placed, the results are as follows. There was only one case of failure of osseointegration 3 months after placement, a posterior zygomatic implant of a zygoma quad; the implant was removed and replaced 6 months later without further complications. There was one case of failure of osseointegration 2 years after placement, a posterior zygomatic implant in a rehabilitation with two posterior zygomatic implants; the implant was removed and replaced 4 months later without further complications. The osseointegration failure rate was, therefore, 0.97%.

However, in some cases, a zygomatic implant was removed, although perfectly integrated, due to other causes and recurrent complications. The following complications were found during the follow-up period:

- One case of sinusitis, 8 months after the placement of a zygoma quad, which was treated with antibiotic, then reappeared 3 years later and was treated again efficiently with antibiotic therapy, without further manifestations.
- One case of sinusitis associated with a zygomatic implant (in a patient treated with two posterior zygomatic implants), which began 2 years after implant placement and was treated with antibiotics and a surgical intervention by an ear, nose, and

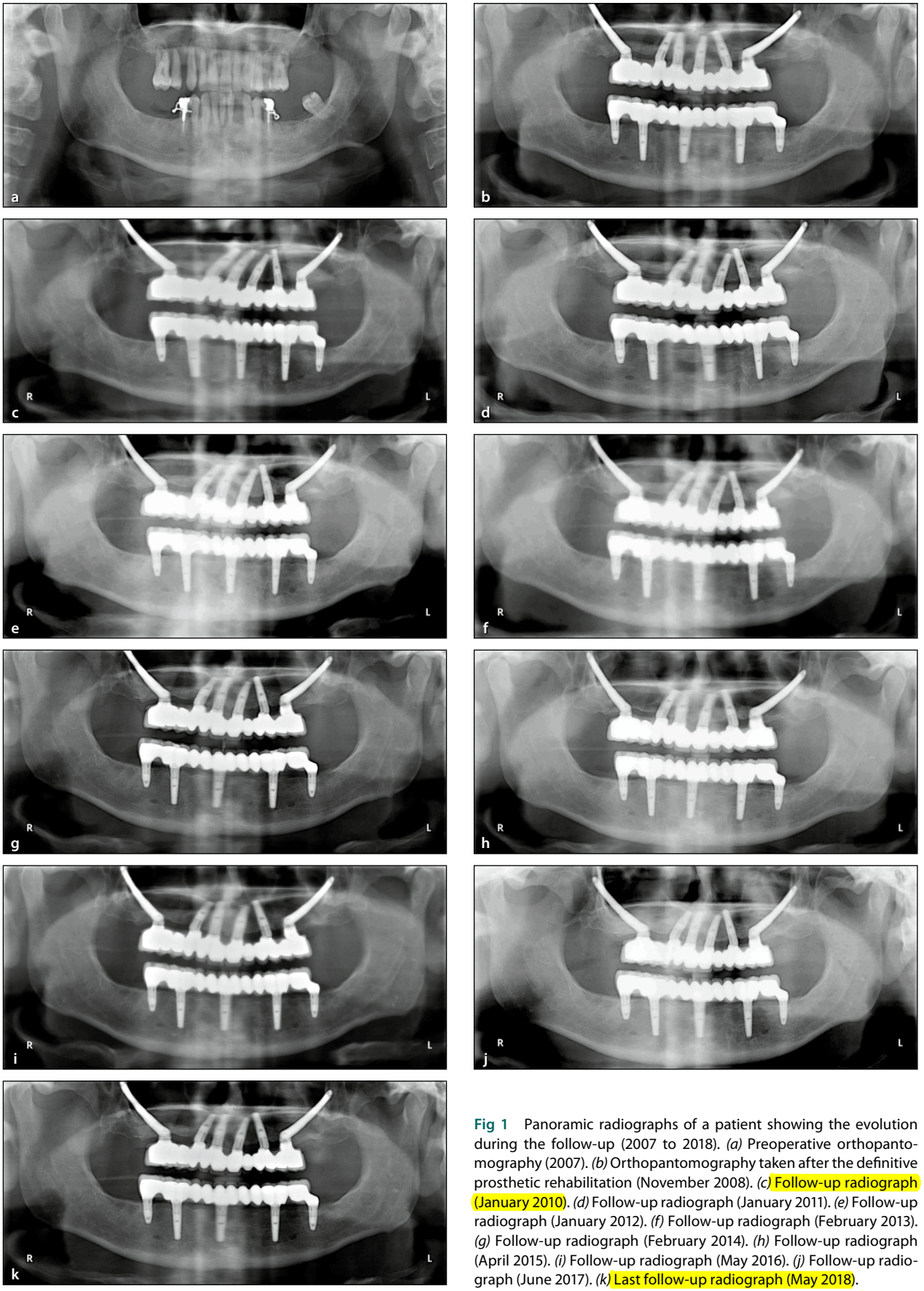

Fig 1 Panoramic radiographs of a patient showing the evolution during the follow-up (2007 to 2018). *(a)* Preoperative orthopantomography (2007). *(b)* Orthopantomography taken after the definitive prosthetic rehabilitation (November 2008). *(c)* Follow-up radiograph (January 2010). *(d)* Follow-up radiograph (January 2011). *(e)* Follow-up radiograph (January 2012). *(f)* Follow-up radiograph (February 2013). *(g)* Follow-up radiograph (February 2014). *(h)* Follow-up radiograph (April 2015). *(i)* Follow-up radiograph (May 2016). *(j)* Follow-up radiograph (June 2017). *(k)* Last follow-up radiograph (May 2018).

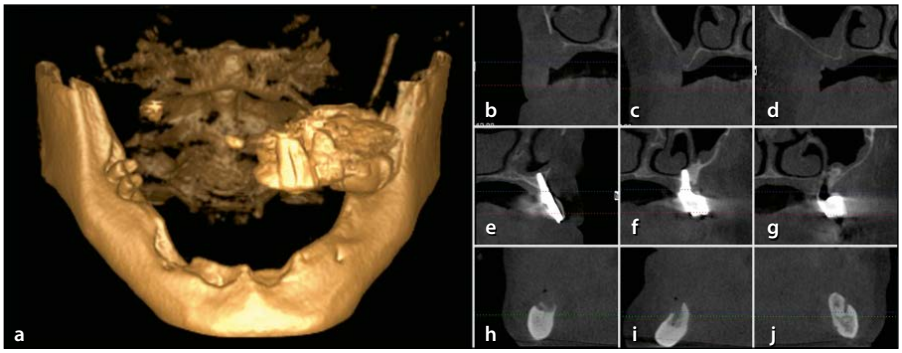

Fig 2 CBCT scans showing a case of iatrogenic maxillary atrophy of the maxilla. *(a)* 3D reconstruction of the jawbones. *(b)* Maxillary right anterior region. *(c)* Maxillary right premolar area. *(d)* Maxillary right molar area. *(e)* Maxillary left anterior region. *(f)* Maxillary left premolar area. *(g)* Maxillary left molar area. *(h to j)* Mandible: right side, anterior area, and left side.

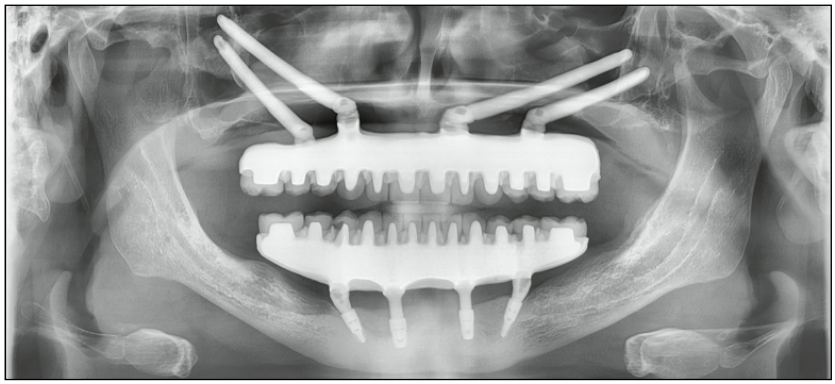

Fig 3 *(Right)* Orthopantomography of the previous patient (Fig 2) taken after the definitive rehabilitation.

Fig 4 *(Below)* Definitive prostheses of the previous patient (Fig 2).

Fig 5 *(a, c, e)* Preoperative and *(b, d, f)* postoperative extraoral appearance of the previous patient (Fig 2).

Table 1 Number of Cases Included in the Study According to the Type of Treatment Applied

1 posterior ZI	23
1 anterior ZI	4
2 posterior bilateral ZIs	53
2 anterior bilateral ZIs	1
2 bilateral ZIs (1 anterior and 1 posterior)	1
2 unilateral ZIs (1 anterior and 1 posterior)	2
3 ZIs: 1 posterior and 1 anterior (unilateral) + 1 posterior (contralateral)	1
3 ZIs: 1 posterior and 1 anterior (unilateral) + 1 anterior (contralateral)	**2**
ZQ	**14**

ZI = zygomatic implant; ZQ = zygoma quad.

Table 2 Number of Patients Included in the Study According to Years of Follow-up and Complications/Failures Observed

Patients	Years of follow-up	Complications/failures
2	12	
2	11	Oroantral fistula and removal of one ZI in 2017 (10 years after surgery)
–	10	
–	9	
3	8	Failure of one posterior ZI (3 months after surgery) with repositioning 6 months later
5	7	
2	6	
9	5	Oroantral fistula and removal of one ZI in 2018 (5 years after surgery) Mucus recession in one anterior ZI Mucus recession in one anterior ZI
11	4	Loss of osseointegration (with no sinus signs/symptoms) in one ZI (2 years after surgery) with repositioning 4 months later Sinusitis 8 months and 3 years later, both controlled with antibiotic
12	3	Recurrent sinusitis 2 years after surgery, which finally leads to the removal of one ZI Sinusitis 1 year after surgery, which reappears 3 years later; it is treated with antibiotics (the patient is currently under ENT's periodic revisions and shows no further symptomatology)
26	2	
30	1	

ZI = zygomatic implant; ENT = ear, nose, and throat doctor.

throat doctor (ENT), but it recurred, and the removal of the zygomatic implant became necessary.

- One case of recurrent sinusal signs and symptoms in a patient treated with a zygoma quad, with the first signs of infection observed less than 1 year after surgery. Currently, 3 years after implant placement, symptomatology is under control, and the patient remains under the supervision of an ENT for strict follow-up and diagnosis of possible future episodes.
- Two cases of oroantral communication (through peri-implant sulcus) with recurrent sinusitis, in which it was necessary to remove the zygomatic implants (in the first case, 10 years after its placement, and in the second case, 5 years later), with both cases being a posterior zygomatic implant in patients rehabilitated with two posterior zygomatic implants.
- Two cases of mucosal recession, both in anterior zygomatic implants in patients rehabilitated with a zygoma quad; recessions are currently stable and do not cause any further complications.

It is specified that the diagnosis of sinusitis was possible, in all cases, thanks to a thorough examination of patients' signs and symptoms and was confirmed through CBCT (performed in the clinic) and also through interconsultation with an ENT specialist.

Since global survival rate refers to the zygomatic implants that remain in the mouth at the time of the study, although the failure of osseointegration occurred in only 0.97% of the cases, there were three more implants that were removed after recurrent maxillary sinus pathology, sometimes associated with oroantral communication. Therefore, of the 206 zygomatic implants placed, 201 remain in the mouth, resulting in a survival rate of 97.57%.

Regarding the global incidence of complications, there was a total of nine cases (4.36%): two failures of osseointegration (0.97%); five cases of sinusitis (2.42%), two of which (0.97%) also presented bucosinusal communication, while the remaining three were not associated with oroantral fistulas (1.45%); and two cases of mucosal recession (0.97%).

It is interesting to note the following key points: the mean follow-up period (calculated from implant placement) was 3.16 years; there was only one case of osseointegration failure at 3 months; the two cases of mucosal recession were both observed in anterior zygomatic implants; and the complications listed above are currently resolved with no acute symptomatology or other associated sequelae. This is the reason why zygomatic implants should be considered an excellent treatment option for patients presenting severe atrophies of the maxilla.

DISCUSSION

The zygomatic implant is a peculiar implant, with specific biomechanical features, different from those typical of conventional implants. Sometimes (most of all in extramaxillary zygomatic implants), when there is no crestal but only apical anchorage, different degrees of stability can be given.[24] In fact, on several occasions, the zygomatic implant may have slight mobility without causing the appearance of any pathologic signs. In addition, this would disappear by splinting the implant thanks to the prosthesis; lateral bending is involved but not a rotational one, with the latter being an indicator of failure. Several studies describe these data in the absence of related complications.[8,14] This aspect, as already explained, is what was examined in each follow-up visit, to determine whether implants were still integrated or showed rotational mobility. Other studies also highlight that the combination of posterior bilateral zygomatic implants with conventional anterior implants generates an excellent biomechanical polygon[3] and has a favorable impact on implant stability, mainly during the healing and bone remodeling phase, when an immediate loading protocol is carried out.[16] Together with the use of definitive prosthetic abutments, the same immediate loading protocol could allow the reduction of oroantral communication, probably from the beginning.[22,34] Biomechanically, these are the reasons that justify why, in the protocol applied in this study, a crestal anchorage is preferred (whenever possible), a bridge of alveolar bone is preserved, transepithelial abutments are placed immediately after implant insertion, and an immediate loading protocol, to splint all implants, is always carried out.

As to the type of prosthesis patients have been rehabilitated with, ie, a fixed screwed structure, according to the results of Lombardo et al,[10] significant differences, depending on the type of prosthesis, can be observed: first, the mean Plaque Index in patients with an overdenture and bar is higher than that in patients who wear fixed prostheses, as well as the index of bleeding on probing and probing depth; second, there are significant microbiologic differences between patients wearing an overdenture and those wearing a fixed prosthesis (percentage of *Porphyromonas gingivalis* of 85.7% and 15.4%, respectively); and third, patients with an overdenture showed higher crestal bone resorption, with this difference being statistically significant. All this could be due to the difficulty in carrying out adequate oral hygiene due to the presence of the bar that splints the implants together.

As far as complications of zygomatic implants are concerned, in the present analyses, a low global complication rate (4.36%) was obtained, with sinusitis being the most frequent complication (2.42%). These results are supported by the literature, which states that zygomatic implants present fairly low complication rates[20] and sinusitis is the most frequent complication, which can appear even several years after implant placement.[34,35] In the literature, the percentage of its incidence ranges from 0% to 26%,[1,8,14,25] with an average of 5% to 7%; specifically, the average frequency found in the studies analyzed in this article is 7.25%.

A direct cause-effect relationship between zygomatic implants and sinusitis has not yet been established,[25,34] and it still remains a controversial debate in the scientific community.[29] Although it is stated that zygomatic implants can cause the appearance of pathologic signs in the maxillary sinuses, especially if they are placed in an intrasinusal position, these alterations do not appear in most patients, and when they do, they frequently remain subclinical.[25] Different hypotheses have been developed on possible causes/risk factors for an association between sinusitis and zygomatic implants: *(1)* the patient's predisposing factors and medical history of previously diagnosed sinusitis[29,34]; *(2)* the use of the classic technique and intrasinusal trajectory of the zygomatic implant; *(3)* the protocol of two-step surgery,[14,29,36] due to the repeated connection/disconnection of transepithelial components that could damage the barrier formed by the soft tissue

fibers and favor the migration of microorganisms as well as the appearance of oroantral communications[29]; *(4)* the smooth surface,[14,29,36] also associated with other specific design characteristics[22,29,34]; *(5)* foreign body reaction with sinus membrane inflammation[22]; *(6)* lack of marginal osseointegration[22,34]; *(7)* remains and particles of surgical waste that remain in the sinus and may obstruct the ostium[34]; *(8)* perforation of the sinus membrane with consequent entry of bacteria from the oral cavity[34]; and finally, *(9)* a chain reaction with the exposition of part of the implant into the sinus, thickening of the membrane, consequent lack of osseointegration with inadequate mucosal sealing, subclinical movement of the coronal components of the implant, and increased probability of oroantral microfiltration.[25] Finally, it is important to consider that, as reported by several studies, the percentage of sinusitis associated with zygomatic implants is low and does not significantly differ from that in patients undergoing maxillary sinus elevation[24,30] or even in the general population.[36] An exhaustive preoperative examination is always advisable, in order to identify patients with an increased risk of sinus complications, due to the existence of previous clinical/subclinical/radiologic signs,[5,24] as well as a rigorous follow-up to assess the health and conditions of the maxillary sinus.[36]

Less frequent complications could be as follows[13,16,25,31,34,35]: soft tissue inflammation (2%), oroantral fistula (0.4%; in this study, its incidence was 0.97%), cutaneous fistula (often due to necrosis for overheating and overtorquing of the zygoma bone), paresthesia of the infraorbital and zygomatic-facial nerves (1%), moderate epistaxis (during the first 3 days after surgery), subcutaneous malar emphysema, and other more atypical complications, such as aspergillosis infection and perforation of the cerebral or orbital cavity (in the latter case, the risk is greater during the placement of anterior zygomatic implants in zygoma quad rehabilitations).

The survival rates of zygomatic implants analyzed in this study are high (97.57%). Similarly, the literature affirms the survival rates of these implants are high (96% to 100%), and according to some studies, favorably comparable to those of conventional implants,[24] with the risk of failure also being similar.[13] For example, in their review, Alqutaibi et al[35] included a total of 68 studies with 4,556 zygomatic implants in 2,161 patients, with 103 failures and a global survival rate of 95.2% after 12 years, concluding that zygomatic implants are an effective treatment for cases of maxillary atrophy. In another review study, Aparicio et al[24] analyzed 32 studies for a total of 1,031 patients and 2,131 zygomatic implants, with a follow-up of 6 months up to 12 years: 42 failures resulted in an overall survival rate of 98.1%, which is higher than that of conventional implants placed in the maxillary anterior region in the same studies (95.9%). In another systematic review, Goiato et al[19] include a total of 1,541 zygomatic implants, of which 33 failures are reported in a mean follow-up period of 36 months (with a survival rate of 97.86%). In addition, in 14 of the 25 analyzed studies, the survival rate was 100%. Chrcanovic et al[34] also performed a systematic review, including 68 articles and 4,556 zygomatic implants, with a global survival rate of 95.2%; in 26 articles, an immediate loading protocol was carried out, showing an excellent survival rate, while a lower one was observed after a two-step surgery approach.

According to the literature, the Zygomatic Anatomy-Guided Approach applied in this study is considered to be a reliable protocol that is able to allow a comfortable prosthetic emergence for patients. For example, Aparicio et al[30] compared the long-term results of zygomatic implants placed by the original technique with those placed by the Zygomatic Anatomy-Guided Approach. Forty-one zygomatic implants were placed with the classic technique and a two-step surgery (control group) and 157 with the modified technique and immediate loading. The survival rate observed in the study was 95.12% in the control group and 97.44% in the anatomy-guided technique group; in addition, the consequences on sinus health were more favorable in this last group with statistically significant differences, as well as the percentage of patients with no signs or symptoms of rhinosinusitis, whose rates do not differ from those found in patients undergoing maxillary sinus elevations.

As far as immediate loading is concerned, it was applied in all the patients of the present study and has been demonstrated to be a reliable protocol for the rehabilitation of zygomatic implants; this may be due mainly to the advantage derived from splinting zygomatic implants with each other or with conventional implants.[36] Several studies in the literature talk about the survival rate of zygomatic implants submitted to the immediate loading protocol. For example, Tuminelli et al[31] performed a review and concluded that the immediate loading of zygomatic implants, with/without conventional implants, seems to be a successful treatment option, with high survival rates (96% to 100%) and few complications, with these latter also having an easy solution. In a retrospective study, Maló et al[29] reported the results of the placement of 92 zygomatic implants with an extramaxillary technique and immediate loading protocol, with a follow-up of 5 years. The overall survival rate was 98.8%; the incidence rate of sinusitis was 16%, and this demonstrates that the risk is higher in patients with a previous history of sinus pathology in which the sinus membrane is not respected. In another study by Maló et al,[23] 747 zygomatic implants were also placed with an extramaxillary

approach and submitted to immediate loading. The overall survival rate was 94.4% after 7 years of follow-up, and the incidence rate of sinusitis was low, ie, 7%. A study by Davó et al[14] included a total of 69 immediately loaded zygomatic implants and showed a global survival rate of 98.5%, demonstrating the high success of (68/69) zygomatic implants after 5 years and, therefore, the excellent mid-term result of this treatment for atrophic maxillae, in line with the global results reported in the literature for zygomatic implants associated with immediate loading.

Finally, as far as zygoma quad is concerned, it was applied in the present study in cases of extreme atrophy of all the areas of the maxilla, since the literature affirms it is a reliable option in this kind of patient, especially from a biomechanical point of view. Aboul-Hosn Centenero et al[13] performed a literature review with the aim of comparing the survival rate of rehabilitation with two zygomatic implants (for a total of 130 zygomatic implants combined with conventional implants) or with zygoma quad (for a total of 196). The results indicated a global survival rate of 98.6% and 97.4% for the treatment with two and four zygomatic implants, respectively, with this difference not being statistically significant, and the authors concluded that the risk of failure is similar to that of conventional implants. Davó et al[8] analyzed the outcomes of zygoma quad treatment in 17 patients, after immediate loading and 3-year follow-up; the overall survival rate was 98.5%, and the percentage of sinus complications was 12%. The same immediate loading protocol in the zygoma quad treatment was applied in the study of Neugarten et al[11]: 105 implants were placed in 28 patients with different techniques according to the anatomical variations, and the overall survival rate was 96%.

As shown in the most recent scientific literature, rehabilitation with zygomatic implants is a predictable treatment, with high survival rates and few (and relatively easy to solve) complications. The limitations of this study are mainly due to the lower number of patients submitted to a larger follow-up period (if compared to those submitted with a shorter one); indeed, 87% of the samples are up to 5 years old. However, the authors consider this an adequate period to support the conclusions of the study. The present study showed a survival rate of 97.57% (though the failure rate of osseointegration was only 0.97%), which can be included in the range of 96% to 100% found in the literature. The low sinus complication rate (2.42%) also confirms the literature data, including the appearance of sinus alterations as the most frequent one.

The Zygomatic Anatomy-Guided Approach applied in the surgeries, according to different studies, would be able to reduce sinus complications if compared with the classic protocol; this could be the reason for the low rate of sinus complications (2.42%). Moreover, the authors believe that this anatomy-guided approach allows for a favorable prosthetic emergence, both in terms of prosthetic rehabilitation and patient comfort. Finally, it is confirmed by the literature that immediate loading is a predictable and favorable protocol that can be applied in zygomatic implant treatments, is able to mechanically stabilize recently placed implants, and is able to drastically reduce the treatment time necessary to restore a good quality of life to the patient.

CONCLUSIONS

In this study, immediate rehabilitation with zygomatic implants in patients with severe maxillary atrophy has been demonstrated to be a fast and predictable treatment, showing a high survival rate (97.57%) and a low biologic complication rate (4.36%). The chance to give a rapid and reliable solution to patients presenting severe maxillary atrophies constitutes an excellent advantage (and an indication) of zygomatic implants, and in the authors' opinion, they may constitute a gold standard treatment for such cases. The authors emphasize the relevance of the predictability of zygomatic implants as a possible solution for severe atrophies of the maxilla, since this problem is often associated with psychologic discomfort for patients, such as poor quality of life and lack of self-esteem.

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