

Review Article

Zygomatic Implants Literature Review and a Clinical Case Involving Bone Grafting and the Importance of the Use of Multiunit ELEMENT[®] Transepithelial Abutments

Iñaki Mayo Fajo^{1, 2, *} , Antonio Mac ías Lloret³ 

¹Oral Surgery and Implants Department, Dentistry School, University of Seville, Seville, Spain

²Oral Prosthetics and TMJ Department, Dentistry School, UIC Barcelona, Barcelona, Spain

³Oral Implantology and Oral Rehabilitation Department, Dentistry School, UIC Mexico City, Mexico City, Mexico

Abstract

Zygomatic implants, originally designed by Dr. Branemark in 1989, are implants which could have 45 to 55 -degree heads of angulation, 4.2 or 4.5 millimeters in diameter at their widest point and measuring between 30 and even 50 or 60 millimeters in length. They are inserted from the palatal aspect of the alveolar process, following the zygomatic-alveolar crest until they are anchored in the body of the malar bone. In maxillomandibular patients, they enter directly into the body of the malar bone. These implants offer the surgeon an alternative when planning implant-supported prosthetic and rehabilitation treatment, especially in patients with severely atrophied upper jaws, where bone grafting is impossible or has previously failed. And also, a reliable and predictable option for immediate loading prosthesis, which is relevant for the comfort, confidence and aesthetics of the patient. The objective of this article is to present the surgical protocol for placing zygomatic implants and a robust review of the current literature on the clinical evolution of these implants and their different techniques. And no less important, to show the advantages, purpose and benefits of using curved and more anatomical transepithelial abutments with a multiunit platform when we need to place an immediate load and definitive full arch prosthesis.

Keywords

Zygomatic Implants, Transepithelial Abutments, Guided Bone Regeneration

1. Introduction

Already at the beginning of contemporary implantology, some professionals began to wonder how they could safely and predictably rehabilitate patients with a highly resorbed upper jaw, when conventional implants did not provide satisfactory results. These patients were usually those who had suffered from untreated periodontal disease for a long time and/or had one or

more removable prostheses. Therefore, offering them zygomatic implants was a possibility of improving their quality of life. In these cases, patients should be aware of the implications of this type of treatment, a surgery that, a priori, was more complex than conventional implants, something that at the time already seemed complex in itself. However, after many years of placing

*Corresponding author: imayo@em.com (Iñaki Mayo Fajo)

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a large number of implants, often with little regard for maintaining their supporting tissues, we find extreme bone loss around these implants. Furthermore, in these patients, we cannot offer an improvement in their quality of life because they already felt comfortable with their implant-supported prostheses. These are patients who are often unaware of the problem with their implants, because unlike teeth with periodontal disease, implants with peri-implantitis remain ankylosed and immobile until they are eventually lost. This is why these patients demand a solution to maintain the comfort they had with their previous rehabilitation with conventional implants, fairly immediately and this time trying to keep their implants and the surrounding tissues as stable over time. However, in the minds of all dentists, the placement of zygomatic implants is a major surgery fraught with risks, such as hematomas, local infections, lip laceration, fistulas, sinusitis or dehiscences [1, 22]. This is why other treatments are proposed to treat patients with severe atrophy.

2. Indications and Contraindications of Zygomatic Implants

The indications for zygomatic implants, as mentioned above, include those patients with severely resorbed posterior maxilla. These Patients may include those with systemic diseases that cause maxilla resorption, patients undergoing maxillary resection or radiotherapy, patients immunocompromised or those with congenital deformities such as cleft palate severe. The most common indications are in: patients for whom grafting bone is not desirable due to possible morbidity in the donor area, increased pain, prolonged surgical time, or even cultural/religious aversion to the material strange bone. [28]

Contraindications for zygomatic implants may be similar to those of conventional dental implants, such as uncontrolled systemic disease, heavy smoking (more than 20 cigarettes a day), radiation therapy to the head and neck, and bisphosphonate therapy. Zygomatic implants pass through the maxillary sinus, their installation may increase the risk of chronic maxillary sinusitis if a patient develops an upper respiratory tract infection that closes the sinus ostium. [28, 22, 24]

Although not a contraindication, it is worth mentioning the possibility of problems with zygomatic implants. However, there is no consensus in the current literature on how to report a diagnosis of rhinosinusitis. [22]

Rhinitis and sinusitis are the most common and frequently associated medical conditions, which is why many authors use the term rhinosinusitis.

Due to its angulation, the head of the zygomatic implant may emerge more palatally than traditional implants. This can make the prosthesis excessively voluminous in that area, which can cause discomfort to the patient (Rosestein 2019).

3. Biomechanical Considerations

If we compare a zygomatic implant and a standard implant,

the former has a greater tendency to bend under the action of horizontal forces, this is due to three factors:

- 1) The great length of these implants (30 to 60 mm).
- 2) Oblique orientation with respect to the occlusal plane.
- 3) The fact that in some cases there is a lack of support in the maxillary area. Based on clinical experience and theoretical biomechanical calculations, Skalak and Zhao (3) propose that a full arch restoration in the maxilla on two zygomatic implants should be stabilized by connecting at least two to four conventional implants in the anterior part of the maxilla. Horizontal forces causing bending moments are the most unfavorable for implants and can alter the long-term stability of an implant-supported restoration. We will counteract the bending moments by (4):
 - a) Full arch stabilization.
 - b) Minimize vestibular lever arms.
 - c) Minimize cantilevers: mesial - distal, anterior - posterior.
 - d) Occlusion control. • Decrease cusp inclination. We join the implants so that the vertical decomposition of forces is axial to the zygomatic implant, and the horizontal components are counterbalanced by the other fixations. Therefore, a rigid, single-piece prosthesis must always be made.

4. Importance of Using Transepithelials and Its Advantages

In this particular case, four zygomatic implants were placed: two anterior and two pterygoid. Each implant included immediate placement of ELEMENT® transepithelial abutments, which, due to their precision, curved profile, and predictability, provide technical security. Finally, immediate loading was placed 24 hours after surgery. The advantages of this are cited in multiple studies, in a "one-time-one-abutment" technique. The meta-analysis conducted in May 2023 by Dr. Yujie Kang showed a total reduction of 0.22 mm in bone mass loss (MBL) at 6 months and a decrease of 0.30 mm at 1 year follow-up in favor of the single-application abutment protocol. Significant MBL loss was observed in equicrestally placed implants with the single-application abutment protocol (6 months: mean difference (MD): -0.22 mm; 95% CI, -0.34 to 0.10 mm, $p = 0.0004$; 12 months: MD: -0.32 mm; 95% CI, -0.40 to -0.24 mm, $P < .00001$), whereas no differences were found between the 2 groups for a subcrestally placed implant (6 months: MD: 0.14 mm; 95% CI, -0.03 to 0.22 mm; $P = .11$; 12 months: MD: -0.12 mm; 95% CI, -0.32 to 0.08 mm; $P = .23$). The study concluded that the implant platform position could greatly affect the marginal bone level. Furthermore, a single-use abutment protocol demonstrated better bone preservation in equicrestally placed implants in healed posterior edentulism. Clinical Relevance: This study highlights the significant clinical application of the single-use abutment protocol in healed posterior edentulism. Moreover, in another

study by Dr. Jos é Vicente R ós-Santos, showed in their results that after one year, the accumulated bone loss was 0.48 ± 0.71 mm for the HEA group and 0.36 ± 0.79 mm for the DEF group, with no statistical significance. Differences due to time were only found between 0 and 6 months ($= 0.001$) and between 0 and 12 months (0.001), with no differences attributable to the study groups (DEF and HEA). The accumulated bone loss (1 year) was 0.45 ± 0.78 mm for the 1 mm abutment group and 0.41 ± 0.70 mm for the 2 mm abutment group ($p = 0.02$). No differences in implant stability were observed between the groups. Conclusions: Abutment design and height, influences bone loss: the higher the abutment, the less bone loss. [36, 37]

5. Description of the Different Techniques

For example, performing a sinus lift or placing immediate implants. However, both options are not without risks [2] and although they have a similar survival rate (around 95%), there are greater prosthetic problems in short implants and more biological complications in sinus lifts [3]. Another option that is often not used is nasal floor elevation [4] but this resource only solves the pillars or the most anterior anchorage of our prosthesis. In addition, for these 3 surgical alternatives, there is usually atrophy of the alveolar crest both horizontally and vertically, so prosthetic emergencies usually end with a crossbite occlusion.

For this reason, another alternative for the rehabilitation of these patients is horizontal and/or vertical regeneration. This way, we can reverse the existing resorption and return the patient to a state prior to significant bone loss. There are several regenerative techniques, such as the use of mesh, blocks, or guided bone regeneration. However, we encounter many difficulties in provisionalization, since in many cases we cannot place the implants simultaneously and must leave them for many months until they can be inserted. And when we can place them, it is absolutely not advisable to place them under immediate load. Furthermore, any type of contact with a removable device on the bone tissue to be augmented is not indicated.

It could be summarized that all of these previous techniques require many months of provisional restorations with removable appliances, and in some cases, a long healing period without any provisional restorations will be recommended.

An alternative to these techniques would be the placement of implants in buttresses. These techniques would allow us to achieve sufficient primary stability for immediate placement of implants and a fixed immediate prosthesis. These techniques have been shown to have a long-term prognosis at least equal to that of conventional implants [3, 5]. They may even have a better prognosis than implants in regenerated areas [1, 2, 6].

And why then is it not a technique widely used for the treatment of these patients with large resorptions? Surely the

answer is varied and may range from the general lack of experience in these techniques to the management of complications. [20] These are varied and highly dependent on the surgical protocol [1, 2, 7]. Initially, the surgical protocol involved starting from a point on the crest-palate and reaching the malar region through the maxillary sinus [8]. Later, in an attempt to reduce the sinus pathology associated with these zygomatic sinuses, sinus elevations with a lateral window began to be performed associated with the placement of implants, first to observe the path of the implant through the sinus while maintaining the Schneiderian membrane intact, and later to graft it to the implant body [9]. In these cases, prosthetic emergencies were very uncomfortable for the restorer, which is why they were often contraindicated for prosthodontic reasons. For this reason, the entry point into the maxilla (the prosthetic emergence of the implant) was shifted towards the vestibular to a more crestal position with a more extrasinusal path to the malar [10-12]. Even the ZAGA classification of zygomatic implants specifies that the most extrasinusal position of some implants does not have a vestibular table (ZAGA 3) or does not even have bone contact in its most coronal portion (ZAGA 4) [11]. The extrasinusal, table-less surgical approach must maintain vestibular bone in the coronal portion and has some very interesting advantages: first, we can start drilling in the malar bone and not in the bone crest; and then use a side-cutting drill. This allows us to use shorter drills and minimize the risk of lip laceration [1], in addition to allowing us to see the entire drilling and path of the implant until its apex is introduced into the malar. Therefore, we will have an implant without the risk of sinus pathology associated with the implant (extrasinusal position), easier to place (simpler drilling protocol and with greater visibility) and a vestibular prosthetic emergence to the crest. [19, 24, 35] This, in a patient with a large bone resorption, will facilitate a better occlusal emergence of the implant platform. However, this extrasinusal position of zygomatic implants and especially cases with absence of vestibular bone in their coronal portion; increases the risk of implant dehiscence [1, 12, 17, 18] and worsens the primary stability of the implant [13].

It has been previously explained that bone regeneration could be the technique of choice for cases of extensive resorption, as it restores bone volume prior to atrophy, but the impossibility of simultaneous implant placement and the difficult provisionalization process seemed to contraindicate this option for most patients. But what if we combine the placement of zygomatic implants in an extrasinus position with guided bone regeneration of the zygomatic implant, which is not surrounded by bone? In this case, we can obtain the benefits of a simpler implant placement technique, without the risk of sinus pathology and with greater control over emergence. [22, 24, 27] We can position the implant more vestibularly than a resorbed bone, simultaneously performing ridge augmentation. [23] In this way, we can improve the stability of the tissues around our zygomatic bones, reducing the risk of mucositis or long-term dehiscence. [29] We can

also offer patients an immediate and fixed restoration without a removable prosthesis over a regenerated area, which would compromise the success of the final restoration. If we also want to reduce the postoperative risks of exposure to the regenerative material, we can remove the Bichat beads, keeping them pedicled, and rotate them medially to cover the vestibular portion of our regeneration. Suturing them to the regenerative membrane will help maintain the fatty tissue in the most critical positions and achieve soft tissue thickening in the vestibular area of the new ridge. [30, 31]

This will further stabilize the peri-implant tissue and increase the thickness of the soft tissue horizontally, generating more mucosal volume. [30, 31]

Treatment with a quadzygoma is a treatment described with a very high success rate [14] but it is known that primary stability is lost in zygomatic implants because they do not have a coronal anchorage [15, 16, 25, 26]. That is why, for biomechanical reasons, our implants must be splinted to reduce micro movement. Something that is also essential to achieve stability in the regenerated area. That is why we consider that the use of an accessory implant to a quadzygoma will reduce the cantilevers, decrease the amount of load that each implant supports and modify the force vector received by the zygomatic implants, ceasing to be so lateral forces to behave more axially [17, 32-34]. These accessory implants can be conventional, short implants or other implants in flying buttresses such as transnasal or pterygoid implants. In this way we will increase the primary stability necessary for the immediate prosthesis. It is known that by reducing the micromovement of the implants and after a period of osseointegration, secondary stability will be achieved 2-3 months after surgery. This reduction in micromovement will also allow us to achieve this "tertiary stability" along the entire path of the zygomatic implant, which was not covered by bone and which we left buried under our guided bone regeneration. In this way, the biomechanical complex will improve its load distribution over time, along with the implanted graft, thereby reducing crestal stress.

6. Discussion

- 1) This study has scientific and personal relevance when reviewing the fundamentals of the zygomatic implant, as it offers an alternative for some situations in which maxillofacial rehabilitation with conventional implants or Bone grafting is not a viable option. a) It reduces surgical time and provides a short cantilever.
- 2) The effectiveness and relevance of placing transepithelial abutments with the "One abutment one time" technique for complete or multiple implant-supported rehabilitations, its advantages, and their importance.
- 3) Regarding the implant survival rate, several authors have calculated the cumulative survival rate (CSR) to assess the long-term longevity of zygomatic implants. Several studies have reported a high CSR, which makes

the rehabilitation of atrophic jaws with zygomatic implants a predictable and feasible procedure compared to other 112 procedures Techno-Humanism. Scientific Journal Vol. 3, No. 3, September - November 2023 Zygomatic implants, indications, techniques and results: Literature Review Marco Antonio Calle Zambrano rehabilitation, such as interpositional grafts with Le Fort I osteotomy or free fibula flaps (Aparicio et al 2014 a, b). According to a study by Aparicio et al (2008) that analyzed 131 zygomatic implants, the TSC over a 5-year period was 100%. In another study by Aparicio et al (2014 a, b), with a 10-year follow-up of 41 zygomatic implants and 131 conventional implants, a TSC of 95.12% was reported for zygomatic implants. This It was also confirmed by the literature review conducted by Chrcanovic et al. (2016), who evaluated 4556 zygomatic implants, calculating a TSC of 95.21% over a 12-year period, with most failures occurring within 6 months after implant installation. Goiato et al (2014), in a review of the literature, showed a TSC of 97.86% for 1541 zygomatic implants, reporting 33 failures caused by sinusitis, infections, or surgical errors. Lombardo et al (2016) reported a 12- to 90-month follow-up study of 65 zygomatic implants, with a TSC of 98.5%, with only 1 case of implant failure due to lack of osseointegration. D'Agostino et al (2021) placed 116 zygomatic implants in 42 patients, reporting a TSA of 97.41%, recommending this treatment as a predictable option for severely atrophied jaws. According to the results reported in the literature on the incidence of sinusitis associated with zygomatic implants, ranges between 0 - 26.6% are discussed. This breadth is probably due to the lack of uniformity in the criteria adopted for the classification of nasosinus disease. Other difficulties in the analysis of These complications consist of establishing a clear correlation between inflammation of the paranasal sinuses and zygomatic implants, since many authors do not reported pre-existing clinical and radiographic conditions (Chrcanovic et al 2016). Aparicio et al (2014 a, b) evaluated a consecutive series of 22 patients with a minimum follow-up of 10 years, rehabilitated with 41 zygomatic implants, all implants placed intrasinusally. Among the various parameters that were taken into account account, the degree of postoperative sinus disease was evaluated using the Score of Lund-Mackay for radiographic findings and the Lanza-Kennedy Questionnaire for clinical findings. In the radiological evaluation, 45.5% of patients 113 "TechnoHumanism" Scientific Journal Vol. 3, No. 3, September - November 2023 Zygomatic implants: indications, techniques, and outcomes: Literature review Marco Antonio Calle Zambrano presented some type of sinus opacity, while 9.1% reported symptoms of sinusitis. D'Agostino et al (2016) analyzed the relationship between the insertion

of zygomatic implants and radiological changes in the sinuses. Preoperatively, 12.2% of patients had a Lund Mackay Score greater than 0, while at the evaluation postoperatively the rate increased to 46.3% of patients. According to the authors, the Installation of zygomatic implants does not appear to be associated with serious complications of the paranasal sinuses, but alterations may still occur asymptomatic radiological examinations of the paranasal sinuses in a considerable number of patients. Regarding peri-implant tissues, Chrcanovic et al (2016) in their review bibliographical, where they analyzed 68 studies for a total of 4556 zygomatic implants, The peri-implant soft tissue infection rate was 2%, in fact, they detected 67 cases of infection found around the implants.

These results are comparable with the data obtained in the proposed systematic review. by Molinero-Mourelle et al (2016), according to which the prevalence of this complication is 4%. Maló et al (2015) performed an analysis of 352 patients, rehabilitated with 747 Zygomatic implants, with a follow-up period of 6 months to 7 years: 54 implants In 54 patients, peri-implant pathology (increased depth of implantation) was reported. probing ≥ 4 mm, bleeding on probing and/or plaque deposits, the situation resolved in 43 patients, 34 of them with non-surgical treatment with curettage and mouthwash chlorhexidine, in 4 cases with antibiotic therapy and in 5 cases with surgery, and the problem did not resolve in 11 patients.

7. Clinical Case

A 44-year-old female patient with a completely edentulous upper jaw and severe maxillary atrophy. She had no significant medical history. She underwent surgery under intravenous sedation. Four zygomatic implants were placed, two pterygoid implants, and two anterior implants with their respective transepithelial abutments were placed using an ELEMENT® (C/ Montealegre 50 Badalona, Barcelona Spain) multiunit platform. A bovine graft was also placed along with a porcine collagen membrane. In this case, both Bichat bags were also placed over the collagen membranes, and finally, an immediate screw-retained provisional was placed 24 hours after surgery.

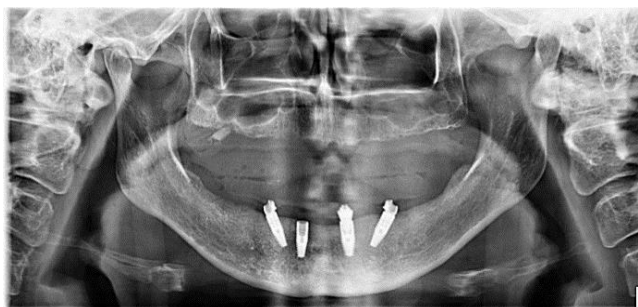


Figure 1. Initial Rx.

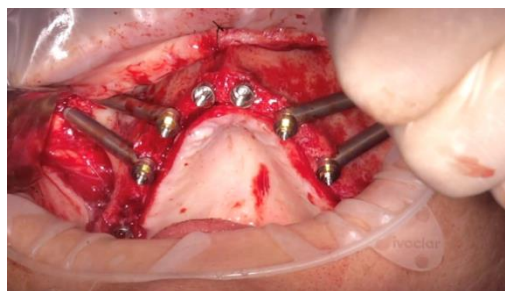


Figure 2. Implants placed.



Figure 3. ELEMENT® Multiunit transepithelial placement.



Figure 4. Placement of graft and membranes.



Figure 5. Placement of graft and 2 membranes.



Figure 6. Placement and suturing of Bichat bags.



Figure 7. Left hemiarch of immediate loading.



Figure 8. Right hemiarch of immediate loading.

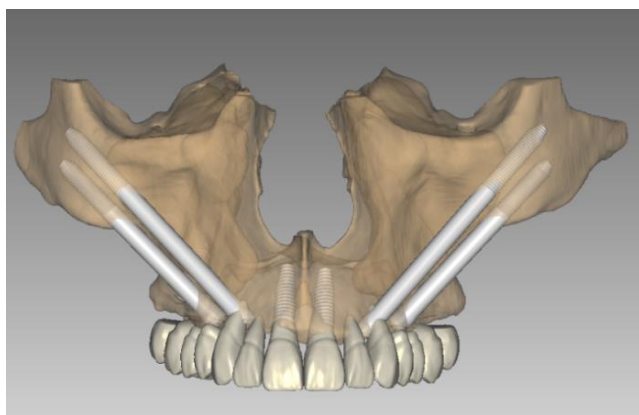


Figure 9. Digital planning of the immediate loading prosthesis.



Figure 10. Digital planning for implant placement.

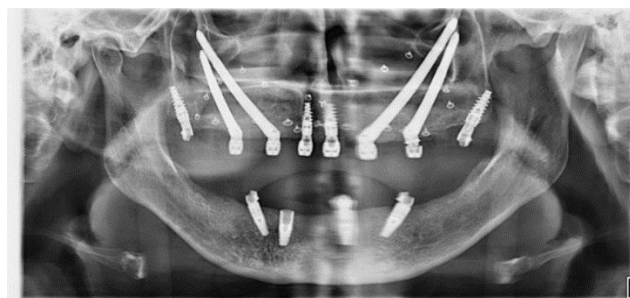


Figure 11. Final X-ray.



Figure 12. Final photo with the immediate prosthesis placed.

8. Conclusions

After many years and thousands of implants placed and rehabilitated in the mouth, zygomatic implants are a good and predictable treatment choice for edentulous patients with large maxillary resorptions requiring immediate fixed provisionalization.

The extrasinusal approach without maintaining vestibular bone in the crestal area simplifies the surgical approach and avoids the most common sinus complications of treatments with zygomatic implants. [22]

The more vestibular positioning of the zygomatic prosthetic platform, together with the placement of accessory implants to the zygomatic bones, improves the biomechanics of the entire system and, therefore, prosthetic stability.

Guided bone regeneration of the crestal portion of the zygomatic bone improves implant stability in the medium to long term and peri-implant tissue in the short and long term. Therefore, it can be concluded that sinusitis associated with the placement of zygomatic implants is a frequent complication, and the intrasinusal technique is more closely related to its development. [21]

Regarding prevention, it should be taken into account that the treatment of previous sinus pathology or the simultaneous performance of antrostomy seem to reduce its occurrence; however, more studies are needed to provide more significant data to support this type of treatment. [22, 24]

That the use of transepithelial abutments in the same surgical procedure for cases such as the one presented in this study is essential for the protection and integration of soft tissues. In addition to offering much greater ease in placing the immediate prosthesis, and of course, increased patient comfort and safety by allowing to wear her temporary teeth 24 hours after surgery, this ensures that by placing the transepithelial abutments—in this case, ELEMENT®(Riera de Montealegre 50, Badalona, Barcelona, Spain), which have a curved design for a biological emergence profile and adequate soft tissue adhesion—in the same surgical procedure—the passive fit, predictability, and unification of all implant platforms when placing the definitive immediate-load prosthesis. It is worth highlighting the precision and, above all, the emergence profile that these abutments in particular provide, with their design developed and conceived from the perspective of biological needs:

Abbreviations

CSR	Cumulative Survival Rate
TSR	Total Survival Rate
TSA	Total Survival Analysis

Author Contributions

Iñaki Mayo Fajo: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing

Antonio Mac ís Lloret: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Supervision, Validation, Writing – original draft, Writing – review & editing

Conceptual Difference

Straight: The pillar emerges perpendicular to the implant, generating a linear emergence profile.

Curved: They present a convex/curved design in their transmucosal portion, better imitating the natural peri-implant anatomy and generating a progressive and smoother emergence profile.

Biological advantages of curved abutments:

Better soft tissue adaptation.

The curved contour allows for a more physiological mucosal seal, promoting biological thickness and gingival stability.

Lower risk of recession and better aesthetics in previous sectors.

Progressive distribution of forces.

The smooth transition from the implant to the crown decreases concentrated stress at the crestal margin.

Greater peri-implant volume.

The curved profile helps preserve and increase space for connective tissue and interdental papillae, resulting in better long-term maintenance of marginal bone.

Optimized aesthetics.

They generate a more natural emergence profile, imitating the dental neck and improving prosthetic integration. [38-40]

Data Confidentiality

The authors declare that no patient data appear in this article. Right to privacy and informed consent. The authors declare that no patient data appear in this article.

Conflicts of Interest

The authors declare no conflicts of interest.

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