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Transcrestal Sinus Lift without Graft Material: A Retrospective Study with 10 to 15 Years of Follow-Up

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Abstract

***Introduction*:** The sinus lift technique is a widely used procedure for the rehabilitation of the atrophic maxilla in terms of height in the posterior regions. Initially, it was performed through a lateral approach with an open window, until a less invasive procedure, the transcrestal elevation, began to be used. Today, this approach is almost exclusively performed, with the lateral approach being reserved for extreme atrophies (1–2 mm in height). Regarding graft material, there have also been modifications over time, evolving from block grafts and particulate autologous bone to mixtures of different materials, and more recently, to graft-free techniques. In these cases, only the pressure from the implant apex and space maintenance contribute to new bone formation within the augmented space. This article presents cases treated with transcrestal sinus lift without graft material, with a follow-up period of up to 15 years. ***Materials and Methods*:** Patients who had undergone a transcrestal sinus lift without graft material and had a minimum follow-up of 10 years and a maximum of 15 years were consecutively recruited. Follow-up evaluations were conducted every six months, assessing bone gain over the implant apex and its stability over time, as well as mesial and distal crestal bone loss and implant survival. ***Results*:** A total of 27 patients who received 45 implants meeting the inclusion criteria were recruited. Among them, 44.4% were women, with a mean age of 68 years (±4.5). The mean initial bone height at implant placement sites was 5.75 mm (±1.11), ranging from 2.07 to 7.10 mm. At the end of the follow-up period, which had a mean duration of 12.8 years (±1.32), ranging from 10 to 15 years, the final mean bone volume at the implant site (implant length + bone gain) was 8.99 mm (±1.91). The mean bone gain over the apex across all implants was 4.21 mm (±1.89). Regarding bone loss, the mean mesial crestal bone loss across all implants was 0.66 mm (±0.46), with a range of 0 to 2.21 mm, while the mean distal crestal bone loss was 0.87 mm (±0.53 mm), ranging from 0 to 3.03 mm. ***Conclusions*:** Transcrestal sinus lift without graft material, using short and extra-short implants along with a specific drilling sequence, is a safe and predictable technique, even in the long term. The results of this study, with a follow-up period of 10 to 15 years, support its effectiveness and reliability.

Keywords: Short implants, Internal sinus lift, Graft-free sinus lift, Atrophic maxilla rehabilitation.

INTRODUCTION

The maxillary sinus elevation technique via a lateral approach, first described by Tatum in 1986, has proven to be a widely used procedure supported by a high success rate [1].

Currently, implants placed using this conventional technique, with various types of graft materials, achieve success rates of approximately 98% [2, 3]. To reduce surgical complexity and minimize associated trauma, transcrestal elevation techniques emerged. These allow access to the maxillary sinus through the residual bone crest, creating an opening that generally matches the size of the osteotomy required for implant placement in the same intervention [4].

Among the advantages of this approach compared to the lateral window technique are a smaller surgical flap, a single access point for both sinus elevation and implant placement, bone compaction at the osteotomy site to enhance primary implant stability, and lower morbidity associated with the procedure [5, 6].

In the early applications of this technique, graft materials were used for transcrestal elevation, following protocols similar to those of the lateral approach. However, later studies demonstrated that transcrestal sinus elevation can be performed without graft materials. Instead, the pressure exerted by the inserted implant maintains the membrane elevation, preventing its collapse and allowing new bone formation in the created space [7-11].

Available studies report that even without the use of grafting materials, significant bone gain is observed during follow-up, ranging from 2.5 mm [12, 13] to 4.4 mm [14, 15]. Additionally, implant survival rates range from 94% to 100% [16]. These findings indicate that the absence of graft material does not negatively affect success rates, provided that the procedure is performed in regions with a residual bone height of 5 to 9 mm [16]. This is crucial for ensuring implant stability in the posterior maxilla, where bone density tends to be low.

Although this recommendation is widely accepted, some studies have demonstrated that implants can be successfully placed in crests with a residual bone volume of 5 mm or less using the transcrestal approach, with implant survival rates ranging from 88.65% [6] to 100% [17]. This success is primarily attributed to improvements in drilling protocols and the achievement of high primary stability, even in areas with moderate-to-severe vertical atrophy.

Our research group previously published a low-speed drilling protocol based on the bone density at the implant insertion site [18], providing guidance for clinicians in more complex cases, such as those involving transcrestal sinus elevation in the posterior maxilla.

In this study, we present a retrospective analysis evaluating the placement of short and extra-short implants in posterior maxillary regions with moderate-to-severe vertical atrophy using the transcrestal sinus elevation technique without graft material. A unified protocol for drilling, implant placement, and prosthetic rehabilitation was applied, with a follow-up period ranging from 10 to 15 years.

MATERIALS AND METHODS

This study included consecutively selected patients in a retrospective analysis, treated at a private clinical center in Vitoria, Spain, between 2014 and 2015. The inclusion criteria were as follows:

- Patients over 18 years of age.
- Vertical atrophy of the posterior maxilla requiring the placement of short or extra-short implants using the transcrestal sinus lift technique without graft material.
- Patients without pre-existing pathologies that contraindicate dental implant placement.
- Patients who continued follow-up from the time of implant placement to the present, allowing for a reported follow-up period of 10 to 15 years.

All patients underwent a thorough preoperative assessment, including diagnostic models, intraoral examination, and a dental cone-beam computed tomography (CBCT) scan, which was subsequently analyzed using specialized software (BTI-Scan III). Additionally, to properly plan the subsequent rehabilitation, a diagnostic wax-up was performed, from which a surgical guide was fabricated.

Prior to implant placement, a premedication regimen was administered, consisting of 2 g of oral amoxicillin one hour before surgery and 1 g of oral paracetamol as an analgesic. Postoperatively, patients continued with oral amoxicillin at 500–750 mg every 8 hours (depending on body weight) for five days.

All implant placements were performed by the same surgeon using the biological drilling technique at low revolutions, without irrigation, and adapted to the density and volume of the recipient site to ensure optimal primary implant stability[18–20]. The final approach to the sinus cortical bone was carried out using a drill specifically designed for this technique (frontal cutting drill). This instrument allows for the precise removal of the maxillary sinus floor while preventing damage to the Schneiderian membrane[21–22]. Once the membrane was exposed through the perforation in the crestal bone, controlled detachment was performed.

Implants were placed using a surgical motor set to 25 Ncm and 25 rpm. The final insertion was completed manually with a torque wrench to ensure precise fixation (Figure 1). Throughout this process, the implant gradually elevated the sinus membrane while being positioned in the osteotomy, ensuring careful and efficient handling. The entire procedure was performed under local anesthesia with a vasoconstrictor. Finally, primary closure was achieved using a non-resorbable 5/0 monofilament suture, which was removed after 10–15 days.

Once the implant was placed, a waiting period of 5 to 6 months was observed before performing the second surgical phase and initiating the prosthetic loading. All implants were restored using transepithelial abutments (screw-retained prostheses) and splinted to other implants with bridges consisting of two or more units. Patients underwent panoramic and periapical radiographic evaluations every six months. These radiographs were used to measure implant stability, crestal bone loss, and apical bone growth over the implant due to new bone formation resulting from the transcrestal sinus elevation. Periapical radiographs were

taken with a positioning device to ensure reproducibility. For panoramic radiographs, patients were positioned using a fixed locator at the glabella and chin, a bite block in the interincisal region aligned with the midline axis, a bipupillary and Frankfurt plane reference (laser marker), and foot placement on pre-marked floor guides to achieve highly reproducible results.

Once acquired in digital format, the radiographs were calibrated using specialized software (ImageJ), utilizing a known reference length (dental implant). After inputting the calibration measurement, the software corrected for magnification distortion, enabling accurate linear measurements.

Crestal marginal bone loss was calculated by measuring the distance from the implant shoulder to the first point where bone-to-implant contact was evident. Apical bone height was measured from the central portion of the implant apex to the newly formed sinus cortical bone, ensuring that the measurement line was perpendicular to the apex at a 90° angle to its flat surface.

Data collection was performed by an independent examiner. The implant was considered the unit of analysis for descriptive statistics regarding implant location, dimensions, and radiographic measurements. The patient was considered the unit of measurement for age, sex, and medical history analysis. A Shapiro-Wilk test was conducted to verify the normal distribution of the sample.

The primary variable studied was vertical bone growth over the implant apex as a result of transcrestal sinus elevation. Secondary variables included implant survival, mesial and distal bone loss, and the long-term maintenance of vertical bone growth achieved during the initial implant placement and loading phase.

Implant survival was calculated using the Kaplan-Meier method. The data were analyzed using SPSS v15.0 for Windows (SPSS Inc., Chicago, IL, USA).

RESULTS

A total of 27 patients were recruited, receiving 45 implants that met the previously described selection criteria. Among the patients, 44.4% were women, with a mean age of 68 years (±4.5).

The mean initial bone height at the implant placement sites was 5.75 mm (±1.11), ranging from 2.07 to 7.10 mm. The implant lengths used varied between 5.50 mm and 7.50 mm, with the most frequently used length being 7.50 mm (73.3% of cases).

The implant diameters ranged from 5.0 mm to 6.25 mm, with the most common diameter being 5.5 mm (51.1% of cases).

Regarding implant position, 26.7% of the implants were placed in positions 16 and 26, making them the most frequently treated sites.

Figure 2 illustrates the distribution of implant diameters and lengths according to their placement position. The predominant bone type in the implant insertion areas was Type II in 71.1% of cases, followed by Type III in 24.4%, and finally, 4.4% of the implants were placed in Type IV bone. The mean initial torque for all implants was 24.67 Ncm (+/- 14.39). Figure 3 illustrates the insertion torques based on position and bone type.

At the end of the follow-up period, which averaged 12.8 years (+/- 1.32), with a range of 10 to 15 years, the mean final bone volume at the implant placement site (implant length + bone augmentation) was 8.99 mm (+/- 1.91). The mean bone height reported above the apex of all studied implants was 4.21 mm (+/- 1.89). The gains observed for each implant at the end of the follow-up period are shown in Figure 4.

Regarding bone loss, the mean mesial bone loss across all implants was 0.66 mm (+/- 0.46), ranging from 0 to 2.21 mm, while the mean distal bone loss was 0.87 mm (+/- 0.53 mm), with a range of 0 to 3.03 mm. Figure 4 presents the mesial and distal bone loss for each implant.

Analyzing the two cases with the greatest bone loss, it was observed that implant number 16 exhibited greater distal bone loss due to hygiene difficulties in the area (intermediate implant 14-15-16). In the case of implant number 43, significant bone loss was associated with a smoking habit of more than 20 cigarettes per day.

Figures 6–28 illustrate one of the cases included in the study.

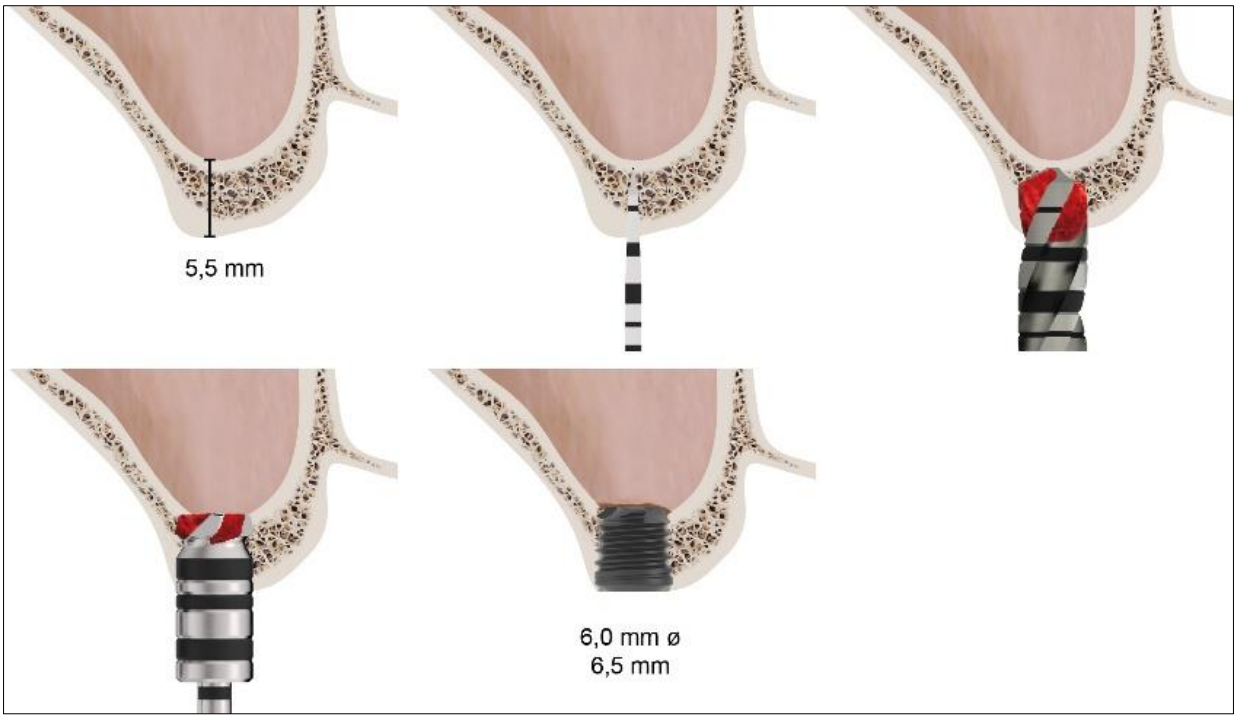


Figure 1: Sequence of transcrestal sinus lift using a front-cutting drill and implant placement without grafting material

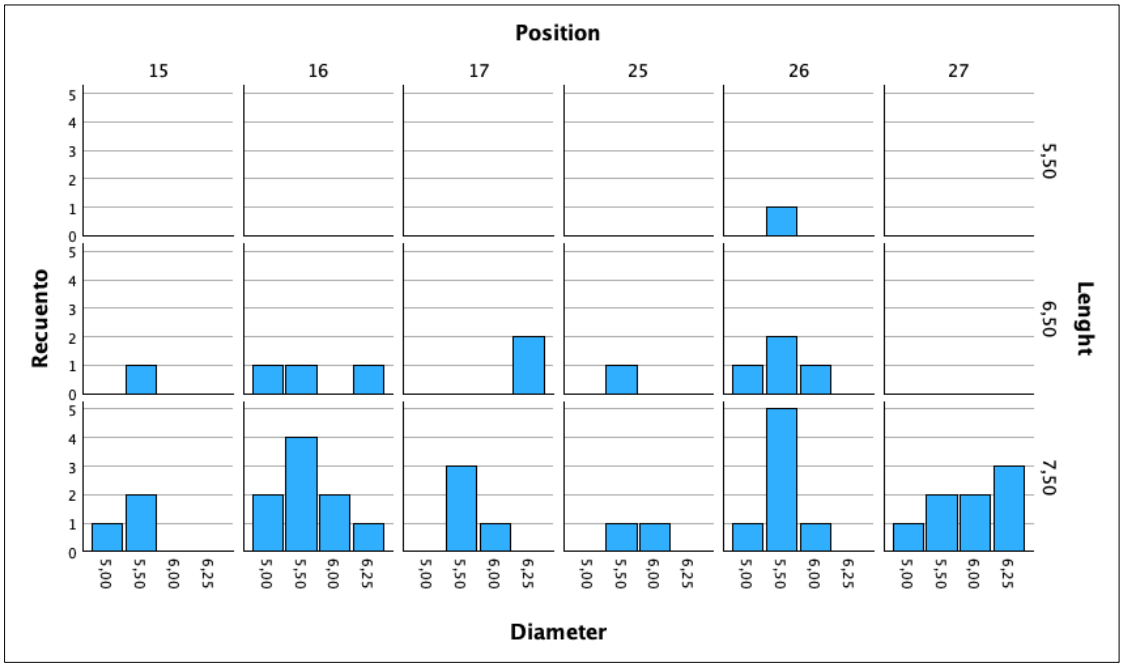


Figure 2: Diameters and lengths of the implants included in the study based on their position

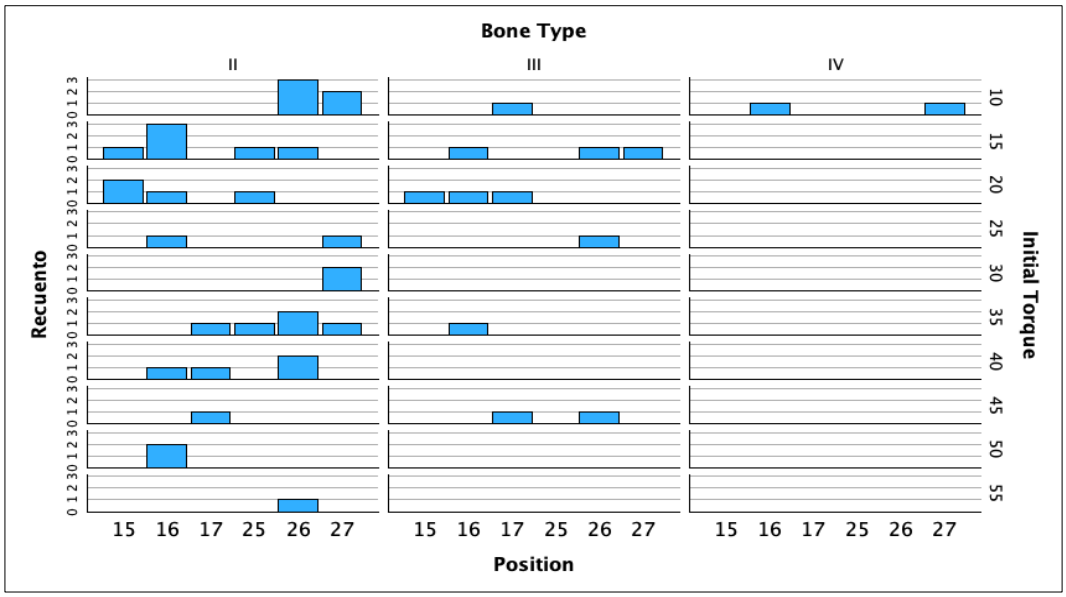


Figure 3: Initial torque based on bone type and implant position

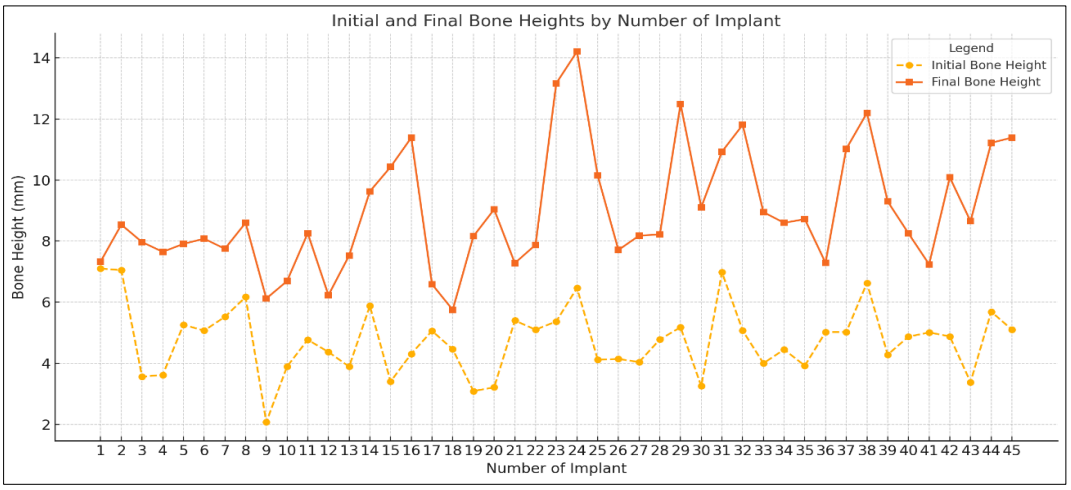


Figure 4: Initial and final bone height for each of the studied implants at the end of the follow-up period

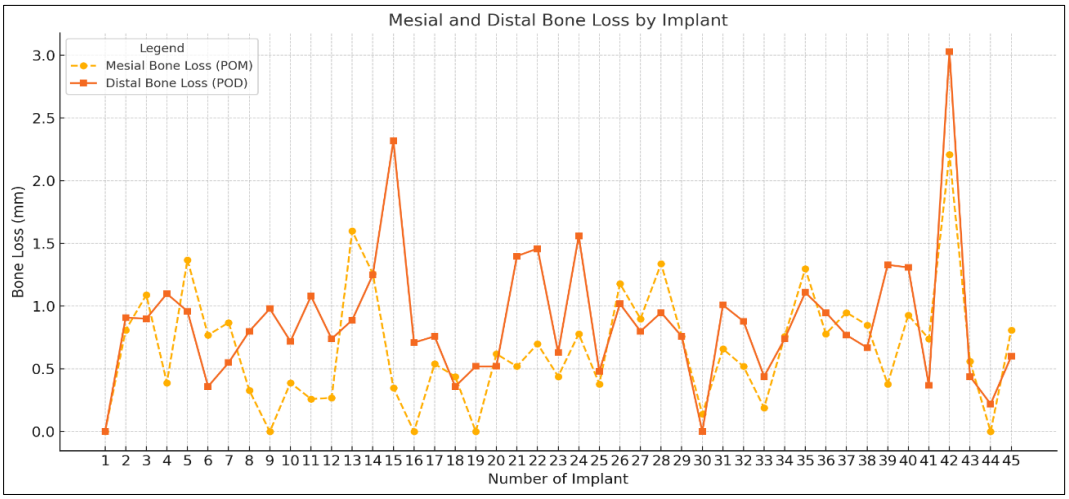


Figure 5: Bone loss per implant in the mesial and distal areas. Implant number 16 showed inadequate access for oral hygiene (intermediate implant in the 14-15-16 bridge), while implant number 42 was associated with a smoking habit of more than 20 cigarettes per day. Implant survival was 100%, with no failures recorded throughout the entire follow-up period

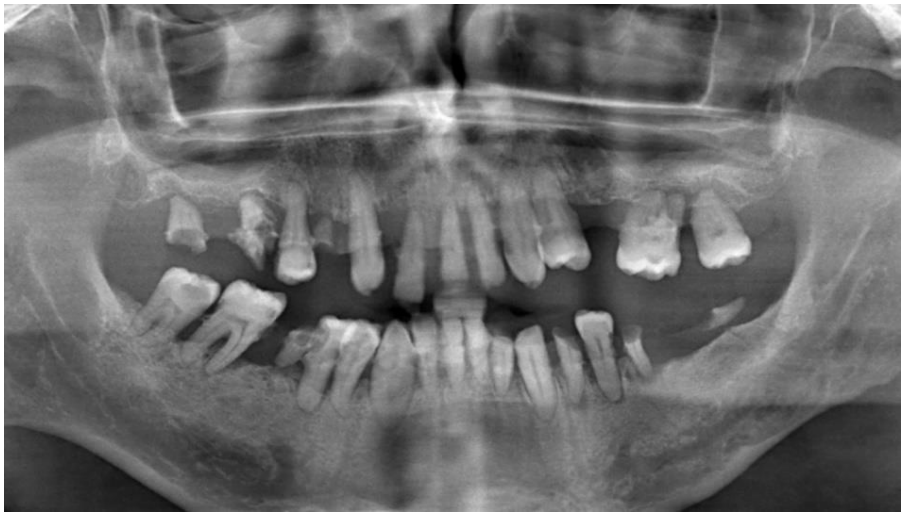
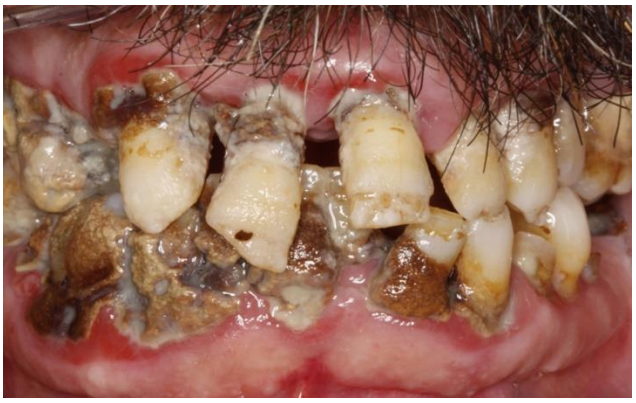
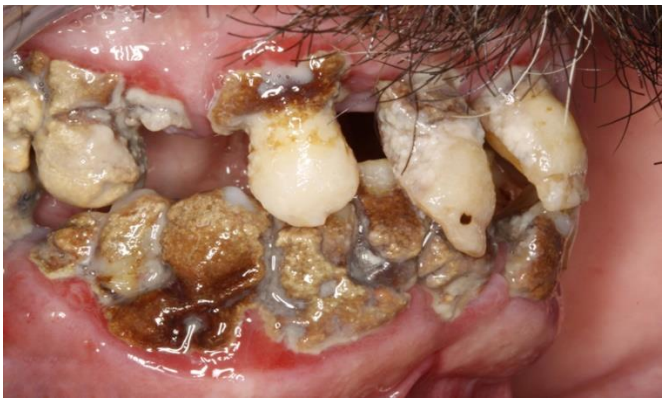


Figure 6: Initial radiograph of the case showing advanced periodontal disease with generalized horizontal bone loss and localized wedge-shaped defects, as well as several root remnants and teeth with a poor prognosis requiring extraction





Figures 7 and 8: Intraoral images of the case, highlighting poor plaque control, which has contributed to the progression of periodontal disease

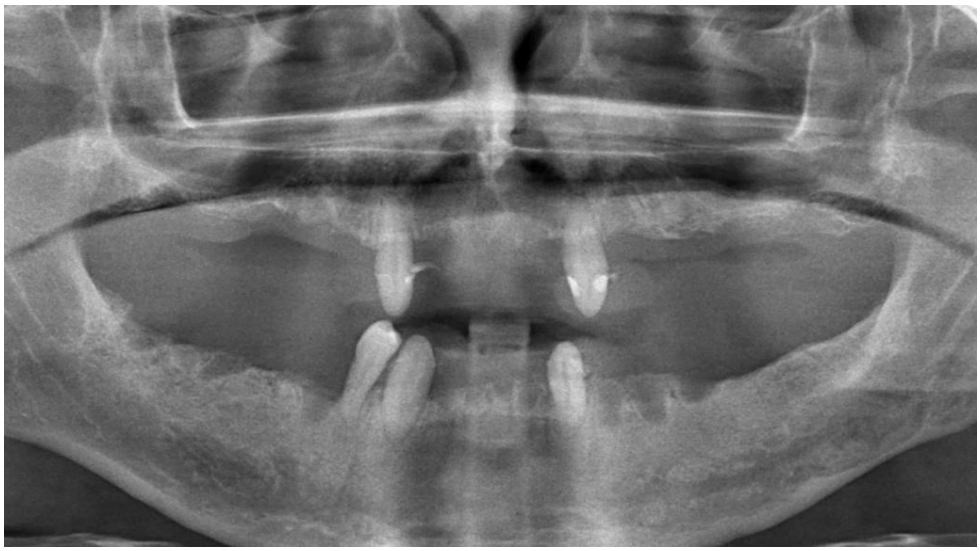
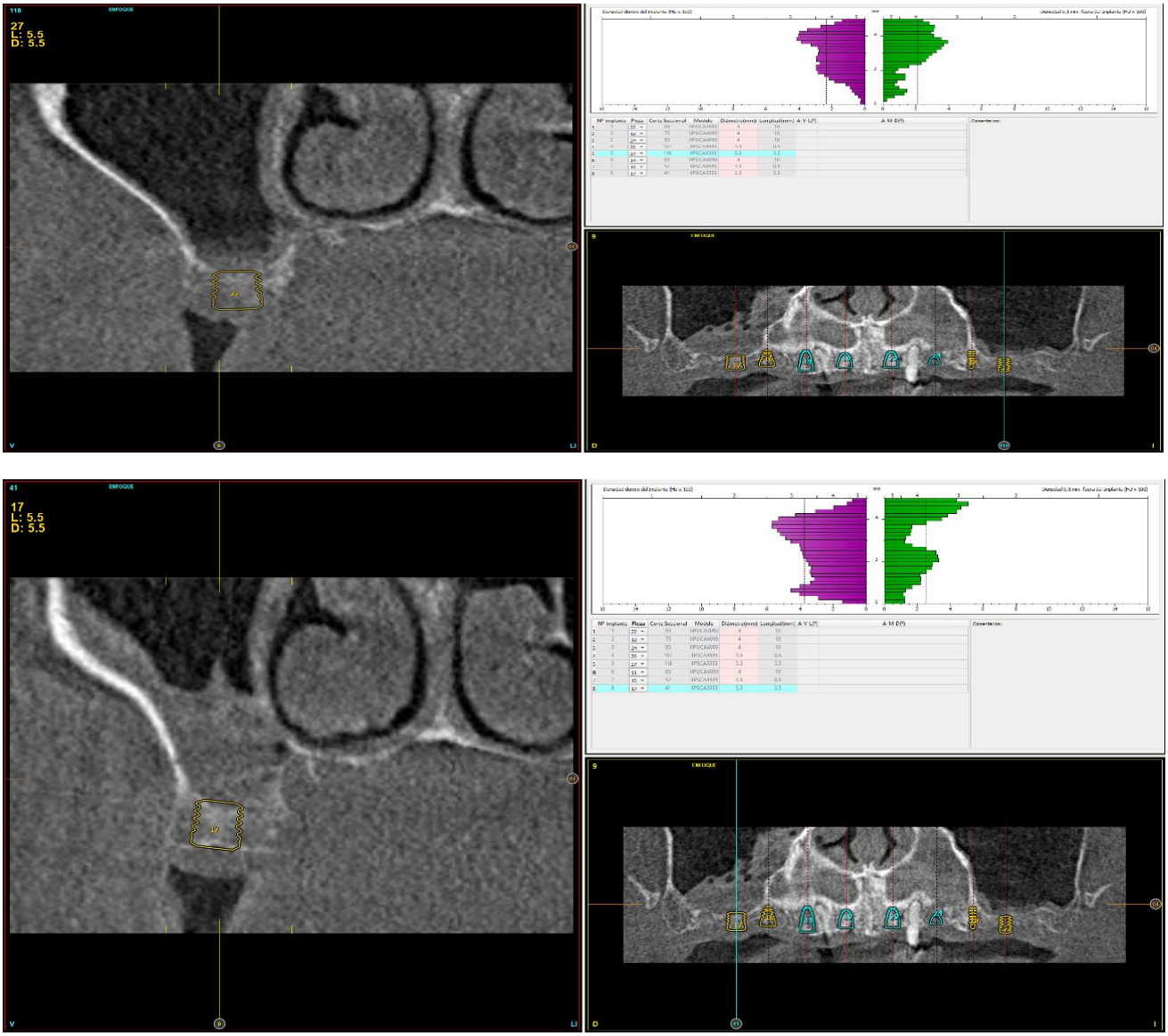
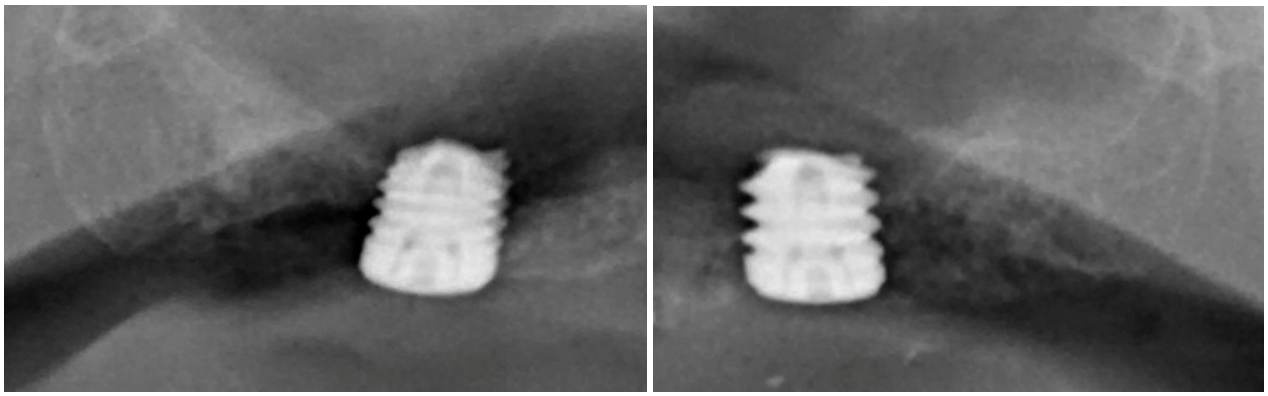


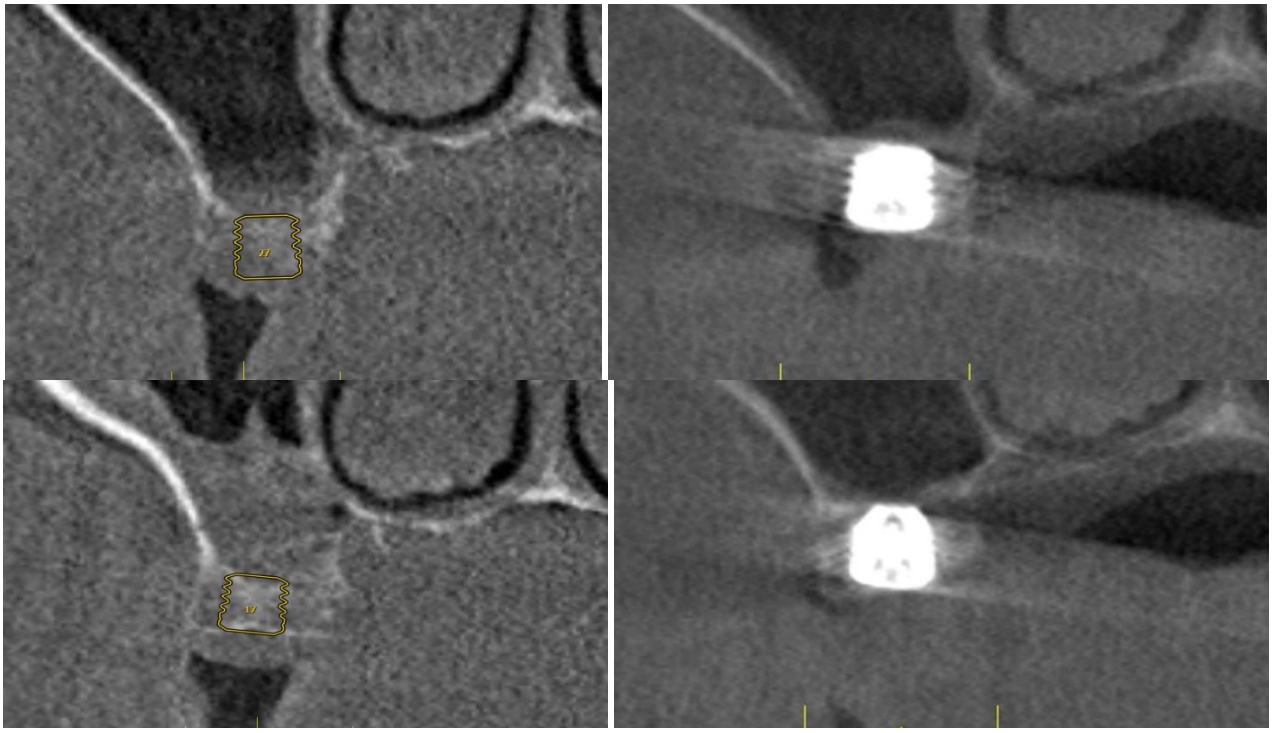
Figure 9: First phase of treatment, including the extraction of teeth with a poor prognosis, meticulous alveolar curettage, scaling and root planing of the preserved teeth, alveolar regeneration with PRGF-Endoret, and placement of a provisional prosthesis on natural teeth while awaiting healing



Figures 10 and 11: Planning of the distal implants placed in both posterior maxillary regions (left and right), where short implants will be inserted with a slight transcrestal sinus lift without grafting material. These implants have a larger diameter due to the low density of the remaining bone



Figures 12 and 13: Post-surgical radiographic images of the implants, showing the apex area where the sinus lift is taking place in both cases



Figures 14–17: Implant planning and the stage following osseointegration before loading

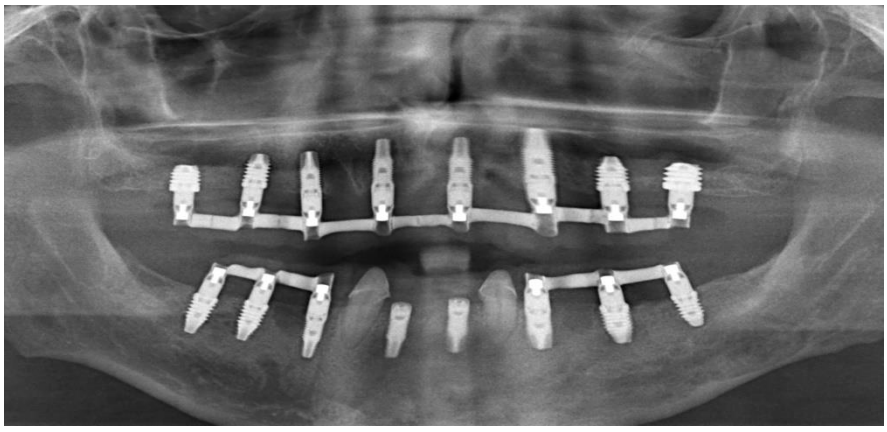
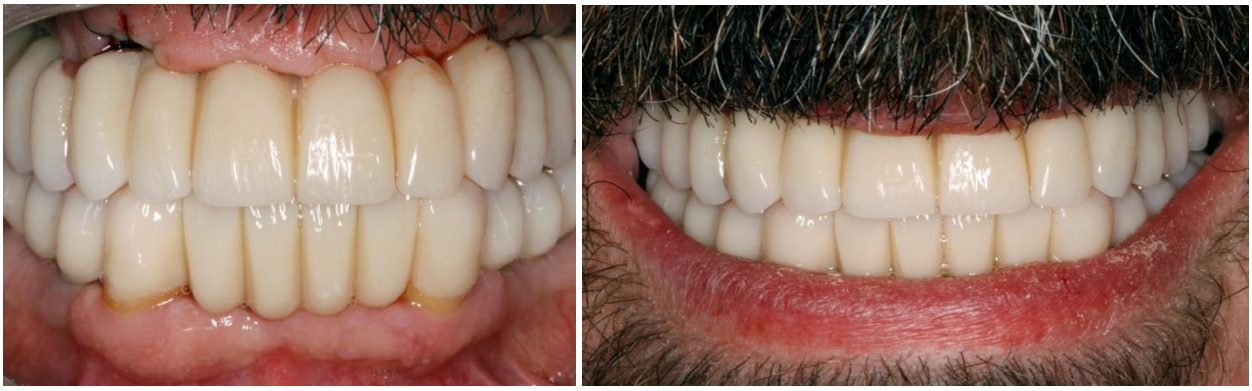


Figure 18: Progressive loading of the upper implants six months after implant placement



Figures 19 and 20: Progressive loading hours after the second surgical phase. This prosthesis will be maintained for several months until stability in the new occlusal pattern is achieved

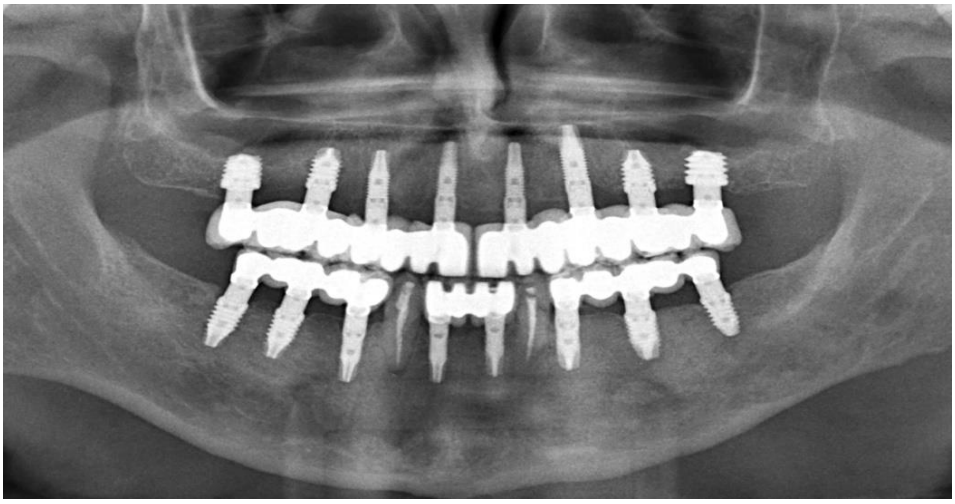
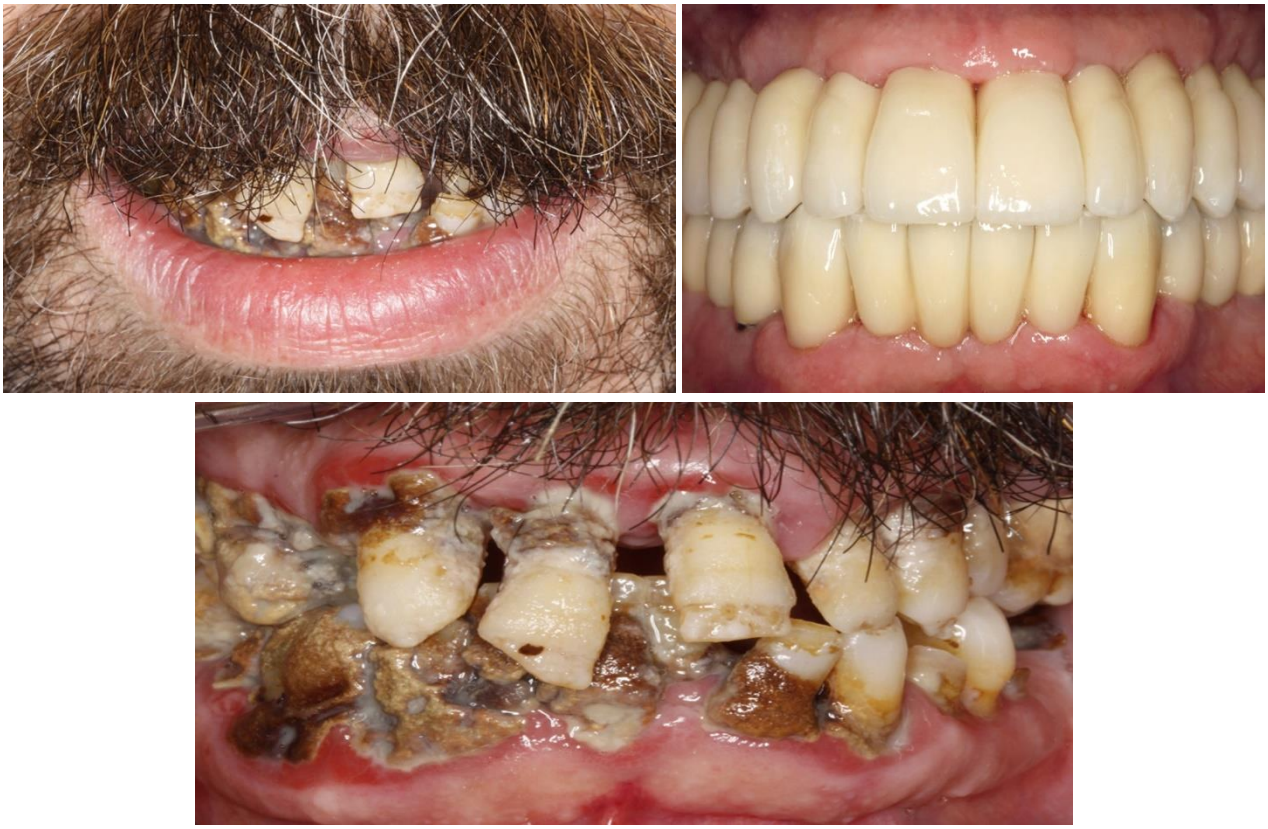
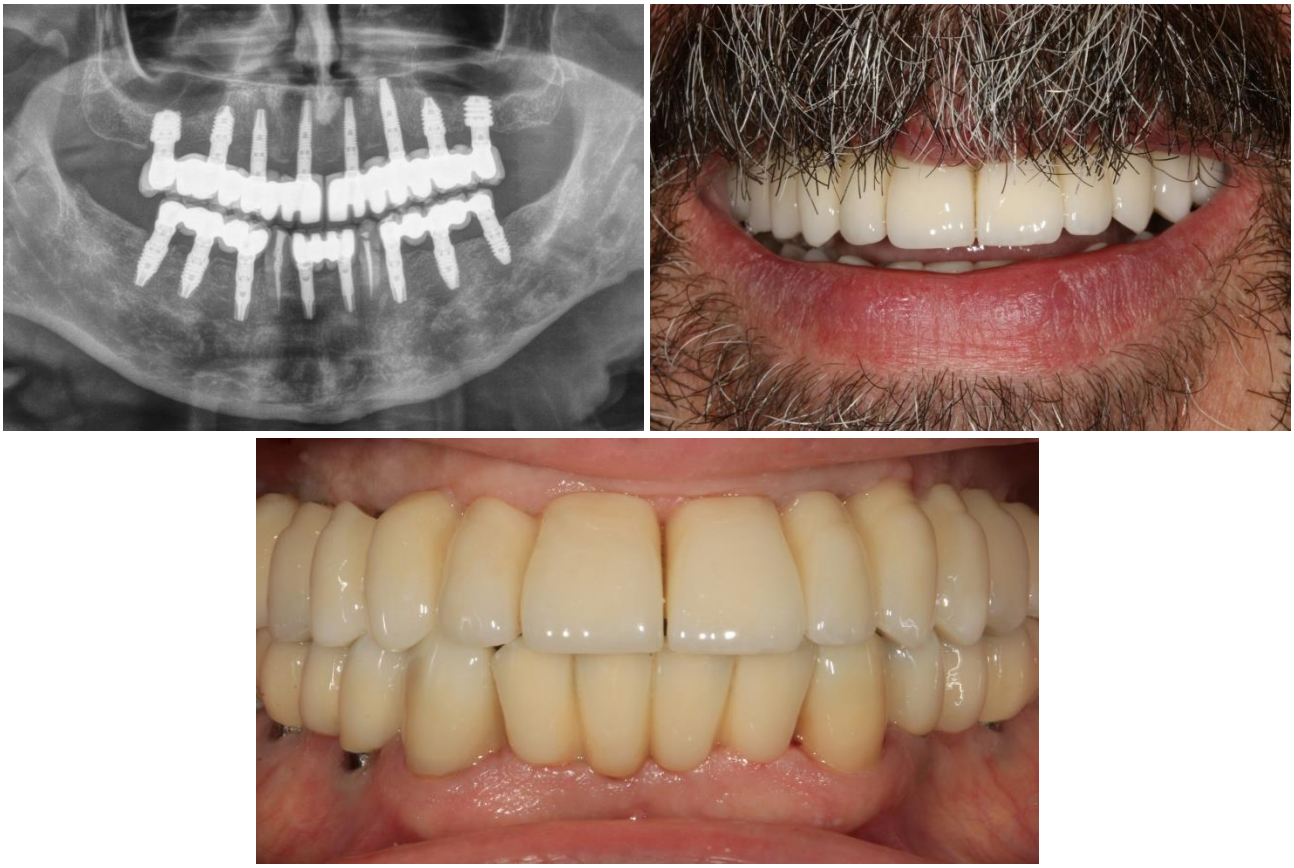


Figure 21: Definitive prosthesis placed in the patient four months after the provisional loading



Figures 22–25: Final images compared to the initial condition, showcasing aesthetic and functional improvements, as well as the achieved periodontal and peri-implant health



Figures 26-28: Radiograph and clinical images at 13 years of follow-up, showing no associated bone loss and the preservation of achieved bone height at the transcrestal sinus lift sites, as well as the maintenance of the two lower canines without bone loss

DISCUSSION

The transcrestal sinus lift technique using short or extra-short implants in a single-stage surgical approach is now a widely accepted option for cases where direct implant placement in the posterior maxilla is not feasible. This approach, which does not require grafting materials, has been validated as a reliable technique, demonstrating implant survival rates of 97.9% in recent studies [2, 3, 5-7].

Studies evaluating the application of short implants combined with transcrestal sinus lift without grafting have reported an average bone gain ranging from 1.8 to 4 mm [6-17]. This variability has sparked debate within the scientific community, particularly because some studies have observed a reduction in initial bone gain over time, from 1.8 mm to 1.3 mm after one year and even down to 1.1 mm after three years [7]. However, other studies have documented consistent results, reporting endo-sinus bone gain of 3.9 ± 1.0 mm after one year and 4.1 ± 1.0 mm after three years [6, 7, 23]. These findings closely align with those of the present study [4.21 mm (+/- 1.8)], with the notable distinction that our follow-up period is significantly longer, ranging from 10 to 15 years.

A systematic review with meta-analysis conducted by Duan *et al*., in 2017 reported vertical bone gain ranging from 3.80 ± 0.35 mm, with a high degree of heterogeneity among the analyzed studies ($I^2 = 98.56\%$; $P < 0.001$) [23]. The diversity of results may be attributed to differences in surgical techniques, implant types (including their morphology and surface characteristics), and drilling methods. In contrast, our data can be considered highly consistent, as all implants were placed using the same surgical technique, planning protocol, and drilling sequence. Additionally, the same implant type was used in all cases, with a homogeneous follow-up period of 10 to 15 years.

Another important factor to consider is the residual bone crest height. In the present study, the mean initial bone height at implant placement sites was 5.75 mm (+/- 1.11). A study by Rammelsberg *et al*., [24] highlighted how implant survival in transcrestal sinus lift procedures is significantly influenced by initial bone height, particularly over long follow-up periods (10 years). The study reported a 77.4% survival rate for sites with an initial height of 1–3 mm, compared to 95.7% for sites with 4–6 mm and 97.6% for heights greater than 6 mm. In our study, only two cases (4.4%) had an initial height of 1–3 mm, while 82.4% of the sample fell within the 3–6 mm range. Notably, no implant failures occurred throughout the entire follow-up period (10–15 years).

Rammelsberg *et al*., [24] also associated lower implant survival in cases with minimal residual bone height with a higher incidence of membrane perforation during implant placement. Their study reported membrane perforation rates of 15.4% in sites with 4–6 mm of residual bone height and 24.4% in sites with less than 3 mm of residual bone. This may be a key differentiating factor between their study and ours, as our implant placement protocol incorporated the use of a front-cutting drill [21, 22, 25] specifically adapted to prevent membrane perforation, ensuring a minimal incidence of sinus membrane perforation and a 100% implant survival rate.

CONCLUSIONS

Transcrestal sinus lift without grafting material, utilizing short and extra-short implants with a specific drilling sequence, is a safe and predictable technique, even in the long term. This is demonstrated by the results of the present study, with a follow-up period of 10 to 15 years.

Conflict of Interest: E.A. is the scientific director of BTI Biotechnology Institute, a dental implant company that investigates in the fields of oral implantology and PRGF-Endoret technology.

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