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Original Research Article **Oral Implantology**

Atraumatic Explantation and Immediate Placement of a New Single Implant in the Aesthetic Zone: Long-Term Clinical Outcomes

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Abstract

Background: The immediate replacement of failed dental implants in the aesthetic zone represents a clinical challenge, particularly when preservation of the surrounding bone and soft tissue architecture is essential. This study aimed to evaluate the long-term survival and marginal bone stability of single implants placed immediately after atraumatic explantation using a counter-torque technique in the anterior maxilla. ***Materials and Methods:*** This retrospective study included 36 patients who underwent atraumatic removal of a single implant and immediate placement of a new implant in the same surgical site, between positions 13 and 23. Explantation was performed using a counter-torque technique. Clinical and radiographic outcomes were assessed over a minimum follow-up period of 10 years after loading. Implant survival, marginal bone loss and surgical outcomes were evaluated. ***Results:*** Thirty-six implants were explanted and immediately replaced. The mean follow-up was 10.67 ±0.72 years (range: 10–12 years). The main reasons for explantation were peri-implantitis (58.3%) and implant malposition (38.9%). All implants were successfully removed using counter-torque, without trephine burs or surgical complications. Immediate replacement was achieved in all patients, with particulate autologous bone required in six cases (16.7%). All replacement implants had a larger diameter than the removed implants, with a mean increase of 0.51 ±0.27 mm. No implant failures were recorded during follow-up, resulting in a survival rate of 100%. Mean marginal bone loss was 0.61 ±0.20 mm mesially and 0.55 ±0.17 mm distally, with an overall mean of 0.58 mm. ***Conclusions:*** Atraumatic explantation using a counter-torque technique followed by immediate replacement of single implants in the aesthetic zone demonstrated favourable long-term clinical outcomes, with 100% implant survival and limited marginal bone loss after more than 10 years of follow-up. This approach may represent a viable treatment option in appropriately selected patients, provided that adequate residual bone and primary implant stability can be achieved.

Keywords: Dental Implant Explantation, Counter-Torque Technique, Immediate Implant Replacement, Aesthetic Zone, Implant Survival, Marginal Bone Loss, Peri-Implantitis.

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INTRODUCTION

Dental implant rehabilitation is a well-established therapeutic option for replacing missing teeth, particularly in the anterior region, where the restoration of function must be accompanied by satisfactory aesthetic integration with the peri-implant tissues and adjacent dentition [1–3]. Advances in implant design, implant dimensions, and surgical and prosthetic protocols have expanded the treatment possibilities for single-tooth edentulism, allowing increasingly complex anatomical situations to be addressed [1-5]. However, the growing use of this treatment modality and the increasing length of time that implants remain in function mean that clinicians are more frequently encountering complications that may compromise implant maintenance and, in certain circumstances, require implant removal [2-6].

Although dental implants have high long-term survival rates, their continued presence in the oral cavity does not necessarily imply the absence of biological, mechanical or aesthetic complications. Howe *et al*., [7], in a systematic review of prospective studies with ten

years of follow-up, reported an implant survival rate of 96.4%. Similarly, Lupi *et al*., [8], in a more recent systematic review analysing prospective studies with a minimum follow-up of twenty years, estimated a survival rate of 93.0%. These findings confirm the high predictability of implant treatment but also highlight that a proportion of implants eventually fail or require removal over time. Conditions that may lead to explantation include advanced peri-implantitis, loss of osseointegration, implant fractures and certain three-dimensional malpositions that prevent satisfactory functional or aesthetic rehabilitation [9–16]. In the anterior region, implant positioning is particularly important, as excessive buccal placement, inadequate depth or an unfavourable relationship with the surrounding tissues may compromise the emergence profile, the stability of the mucosal margin and the aesthetic harmony of the restoration [17–20].

The need to remove an implant in the aesthetic zone presents a particularly complex clinical challenge. In addition to the loss of the previous restoration, there is a risk of altering the bone and mucosal architecture that determines the outcome of subsequent treatment [21–23]. Conventional explantation procedures, based on the use of trephine burs, peri-implant bone drilling or implant luxation, may require the removal of part of the surrounding bone and create defects that hinder the immediate placement of a new implant [24–27]. Depending on the morphology of the residual defect and the primary stability that can be achieved, regenerative techniques and delayed reimplantation may be necessary, increasing the complexity of retreatment, the number of surgical interventions and the time required to complete rehabilitation [27–30].

Conservative explantation techniques are therefore particularly relevant in aesthetic areas, where additional bone loss may make the difference in achieving successful subsequent rehabilitation in terms of both aesthetics and implant survival. In 2012, our research group described a counter-torque explantation procedure designed to reverse implant osseointegration while minimising the removal of surrounding bone and facilitating, when clinical conditions permit, the placement of a new implant during the same surgical procedure [31]. Unlike procedures requiring a circumferential osteotomy, counter-torque acts on the bone–implant interface and allows a greater proportion of the available bone structure to be preserved. Preservation of the recipient site may facilitate the achievement of primary stability for the new implant and reduce the need for additional reconstructive procedures, although the feasibility of immediate reimplantation depends on the integrity of the bone walls, the presence of associated defects and the characteristics of the residual bone. These considerations are particularly important in single-tooth rehabilitations in the aesthetic zone, where preservation of the buccal bone volume and soft tissue architecture is essential for achieving a restoration that integrates with the adjacent teeth [20-33]. The possibility of removing an implant and immediately placing a new one could help reduce the number of surgical interventions and treatment times, while also allowing correction of an unfavourable implant position or replacement of an implant with a poor prognosis. Nevertheless, preservation of the bone site during explantation does not, in itself, guarantee subsequent stability of the peri-implant tissues, making it essential to evaluate the long-term clinical and radiographic outcomes of the replacement implants.

The possibility of placing a new implant immediately after the removal of a previously failed implant has been evaluated in several studies, although the published findings show considerable heterogeneity regarding the causes of initial failure, reimplantation protocols and characteristics of the rehabilitations [32–36]. Grossmann and Levin [36], in a study of 31 single implants placed at sites previously affected by implant failure, reported a survival rate of 71% after a mean follow-up of 19.4 ±11.4 months. However, only three implants were inserted immediately after explantation, whereas the remaining implants were placed after a delay, with a mean interval of 5.8 ±5.2 months. Subsequently, our research group [37], evaluated 22 implants placed immediately after the removal of implants affected by peri-implantitis in 17 patients, obtaining a survival rate of 94.7% after a mean follow-up of 40 ±16 months, with mesial and distal marginal bone losses of 0.89 ±0.62 mm and 0.97 ±0.66 mm, respectively. In a larger retrospective series conducted by our group [38], 381 implants placed in regions where previous implants had failed due to peri-implantitis were analysed, of which 164 (43%) were inserted during the same surgical procedure as explantation. Cumulative survival was 99% after a mean follow-up of 34 ±17 months, with no significant differences between immediate and delayed reimplantation ($p = 0.765$). However, only seven implants in this series were restored with single crowns, whereas the majority formed part of partial or full-arch rehabilitations. These findings support the feasibility of reimplantation at previously compromised sites but highlight the scarcity of specific data on single implants placed immediately after explantation in the aesthetic zone. Therefore, the aim of the present study was to evaluate the long-term survival and marginal bone stability of single implants placed immediately after atraumatic explantation using a counter-torque technique in the aesthetic zone (between positions 13 and 23), as well as to analyse the surgical, biological and prosthetic complications recorded during follow-up.

MATERIALS AND METHODS

A retrospective study was conducted involving patients treated at a dental clinic in Vitoria, Spain, who underwent implant explantation followed by immediate placement of a new implant at the same surgical site, in the aesthetic zone between teeth 13 and 23, between

2013 and 2014. Data were collected retrospectively through a review of the clinical records of patients who met the inclusion criteria and whose procedures had a minimum follow-up of 10 years after loading.

In all cases, diagnostic assessment and surgical planning were performed using cone-beam computed tomography (CBCT), which allowed three-dimensional analysis of the position of the implant to be explanted, identification of potential anatomical and bone-related limitations to its removal, and planning of the position of the new implant to be placed immediately in the same surgical site.

As preoperative prophylaxis, patients received 2 g of oral amoxicillin one hour before surgery. In addition, 1 g of oral paracetamol was administered as analgesic medication. All procedures were performed by the same surgeon under local anaesthesia with articaine hydrochloride and epinephrine 1:100,000. Surgical access was achieved by raising a full-thickness mucoperiosteal flap to adequately expose the implant to be removed and allow direct visualisation of the surrounding bone structures. Explantation was performed using the implant extraction system developed by BTI Biotechnology Institute (Vitoria, Spain), previously described in the literature [31-39]. This procedure is based on the controlled application of counter-torque using a specific extractor that engages with the implant connection. The progressive transmission of this force in an anticlockwise direction overcomes the resistance of the bone–implant interface and achieves implant disosseointegration, minimising the need to remove peri-implant bone.

Following implant removal, the recipient site was inspected and thoroughly curetted to eliminate any inflammatory or granulation tissue present. In cases where the integrity of the bone walls and the characteristics of the remaining bone allowed adequate primary stability to be achieved, a new implant was immediately inserted at the same site. For this purpose, limited drilling was performed, adapted to the dimensions and characteristics of the new implant, to adjust the geometry of the recipient site to its diameter and length while preserving as much of the available bone volume as possible. When a residual gap was identified between the surface of the new implant and the walls of the explantation site, it was filled with particulate autologous bone harvested during drilling at other sites and mixed with previously activated fraction 2 of PRGF-Endoret. Once implant insertion was completed, a fibrin membrane obtained from activated and retracted fraction 1 of PRGF-Endoret was placed over the treated area. Finally, the flap was repositioned and closure was achieved using 5/0 non-resorbable monofilament sutures.

All implants followed a two-stage surgical protocol, remaining submerged during the initial healing period. Postoperative follow-up included scheduled clinical examinations at 15 days, one month, three months, six months and one year after surgery, followed by periodic long-term assessments.

Peri-implant bone changes were evaluated using intraoral radiographs obtained during follow-up. Measurements were performed using Sidexis XG software (Sirona Dental Systems, Bensheim, Germany), after calibrating each image against a known dimension corresponding to the implant length to correct for potential variations in radiographic magnification. Marginal bone loss was determined by measuring the distance between the implant shoulder and the first radiographically identifiable point of contact between the bone and the implant surface. Measurements were performed independently on the mesial and distal aspects of each implant. The radiograph obtained at the time of definitive prosthesis placement was used as the baseline reference, so that bone changes recorded at subsequent follow-up examinations were calculated relative to this initial measurement. Mesial and distal marginal bone changes were determined for each implant. This procedure allowed quantification of the marginal bone changes occurring during the functional follow-up of the replacement implants.

RESULTS

A total of 36 patients were included, who underwent atraumatic explantation of 36 single implants located in the aesthetic zone, followed by immediate placement of a new implant in the same surgical site. The mean follow-up was 10.67 ±0.72 years, ranging from 10 to 12 years. Seventeen patients (47.2%) had a follow-up of 10 years, 14 (38.9%) of 11 years and five (13.9%) of 12 years.

Regarding anatomical distribution, the most frequent location was position 21, with 11 implants (30.6%), followed by positions 11 and 22, with seven implants each (19.4%, respectively). Positions 12 and 13 accounted for four implants each (11.1%), and three implants (8.4%) were located at position 23 (Figure 1).

The most frequent reason for explantation was peri-implantitis, recorded in 21 patients (58.3%), followed by implant malposition, present in 14 cases (38.9%). One additional implant (2.8%) was removed due to the combined presence of an infectious focus and overload. Among the implants explanted due to peri-implantitis, 15 (71.4%) were classified as stage IV and six (28.6%) as stage III, according to the Jovanovic classification [40]. All 36 implants were successfully removed using the counter-torque procedure, with no explantation failures or surgical complications recorded. The counter-torque required to achieve implant disosseointegration ranged from 20 to 200 Ncm, the latter being the maximum limit applied during the procedure. The most frequent value was 200 Ncm, recorded in 15 implants (41.7%), followed by 150 Ncm

in seven cases (19.4%) and 100 Ncm in four (11.1%). Overall, 21 implants (58.3%) required a counter-torque of 175 Ncm or greater, whereas the remaining 15 (41.7%) were removed using lower values.

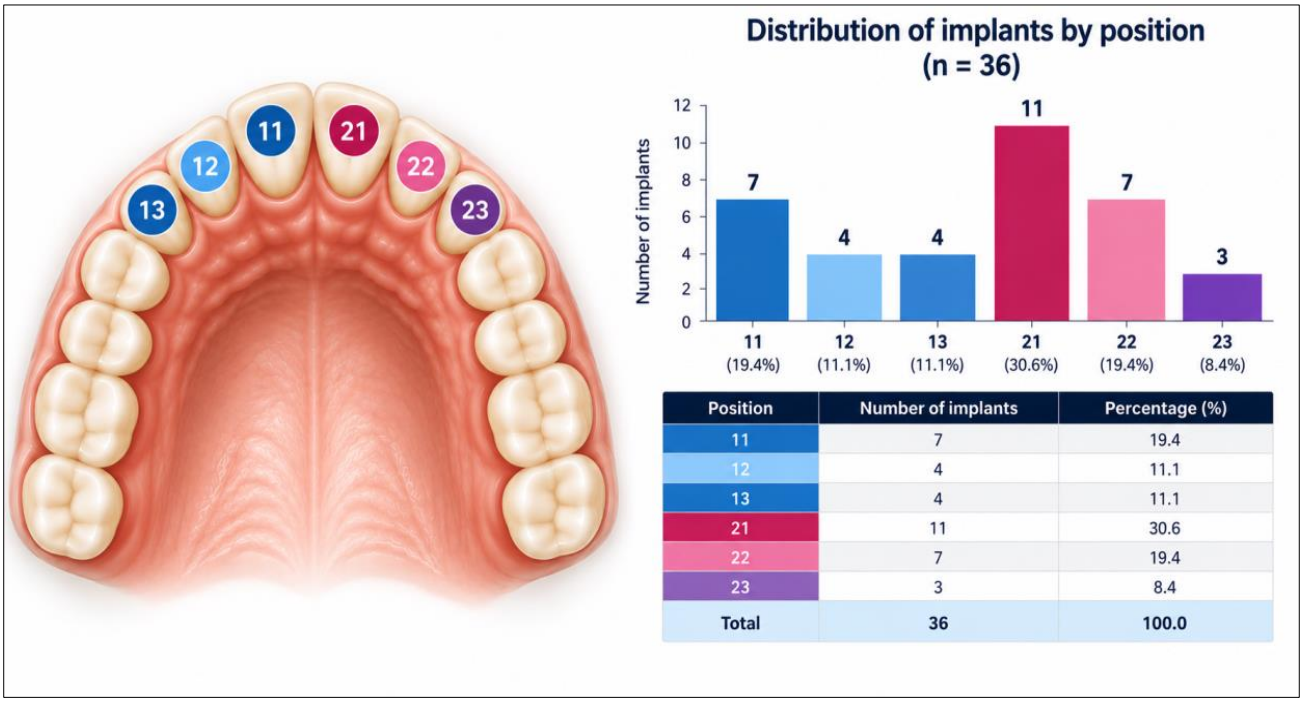
Extractor No. 1 was used in 31 procedures (86.1%), extractor No. 2 in three (8.3%) and extractor No. 3 in two (5.6%). The use of trephine burs was not required to complete implant removal in any of the cases.

In all patients (100%), it was possible to place a new implant immediately after explantation, using the bone site previously occupied by the removed implant. Immediate loading was also performed in 11 of the 36 implants. The length of the new implant was equal to that of the explanted implant in 16 cases (44.4%), whereas it was increased by 0.5 mm in 15 patients (41.7%) and by 1 mm in five (13.9%). The mean increase in length was 0.35 ±0.36 mm, ranging from 0 to 1 mm. Furthermore, all new implants had a larger diameter than the removed implants, with a mean increase of 0.51 ±0.27 mm and a range of 0.25 to 1.25 mm. The most frequent modification was an increase of 0.5 mm, recorded in 15 cases (41.7%), followed by increases of 0.25 mm in 13 patients (36.1%), 1 mm in four (11.1%), 0.75 mm in three (8.3%) and 1.25 mm in one case (2.8%) (Figure 2).

In six patients (16.7%), particulate bone was required to fill the residual gap between the new implant and the walls of the recipient site, whereas this procedure was not required in the remaining 30 patients (83.3%).

No failures of the replacement implants were recorded during follow-up, resulting in a survival rate of 100% at the end of the observation period, which ranged from 10 to 12 years.

Radiographic evaluation at the end of follow-up showed a mean marginal bone loss of 0.61 ±0.20 mm mesially and 0.55 ±0.17 mm distally. Mesial values ranged from 0.22 to 0.90 mm, whereas distal values ranged from 0.33 to 0.89 mm. The overall mean marginal bone loss, calculated as the arithmetic mean of the mesial and distal measurements for each implant, was 0.58 mm. Figures 3–15 illustrate one of the cases included in the study.



Position	Number of implants	Percentage (%)
11	7	19.4
12	4	11.1
13	4	11.1
21	11	30.6
22	7	19.4
23	3	8.4
Total	36	100.0

Figure 1: Distribution of explanted and reimplanted implants

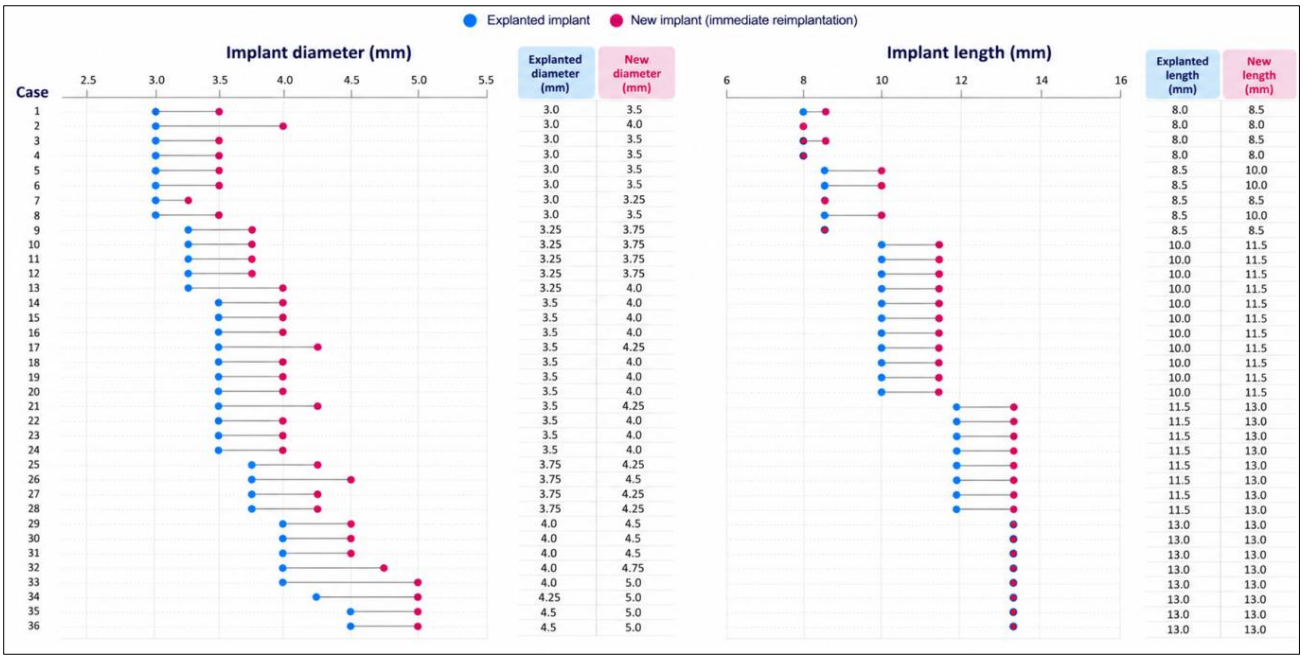


Figure 2: Diameter and length of the original implants and those reimplanted in the post-explantation site



Figures 3 and 4: Initial clinical images of the case showing the implant positioned at tooth 21, with poor soft tissue conditions and inflammation. A fistula can also be observed, despite two previous connective tissue grafts performed in an attempt to correct the deficiency of keratinised gingiva

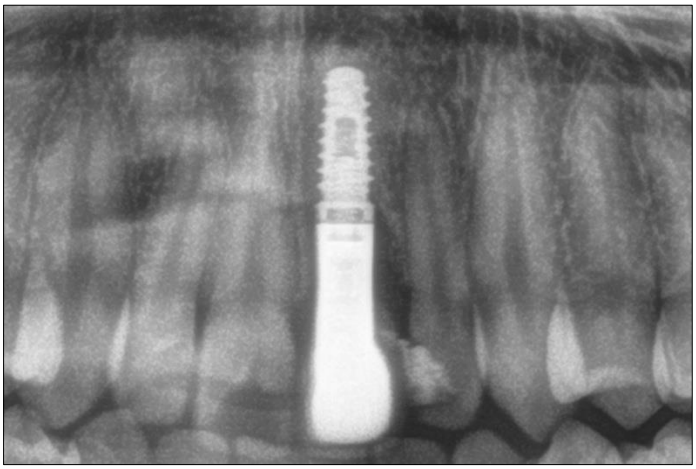


Figure 5: Initial radiograph of the case showing the restored implant in an incorrect apicocoronal position, with a very long transmucosal path

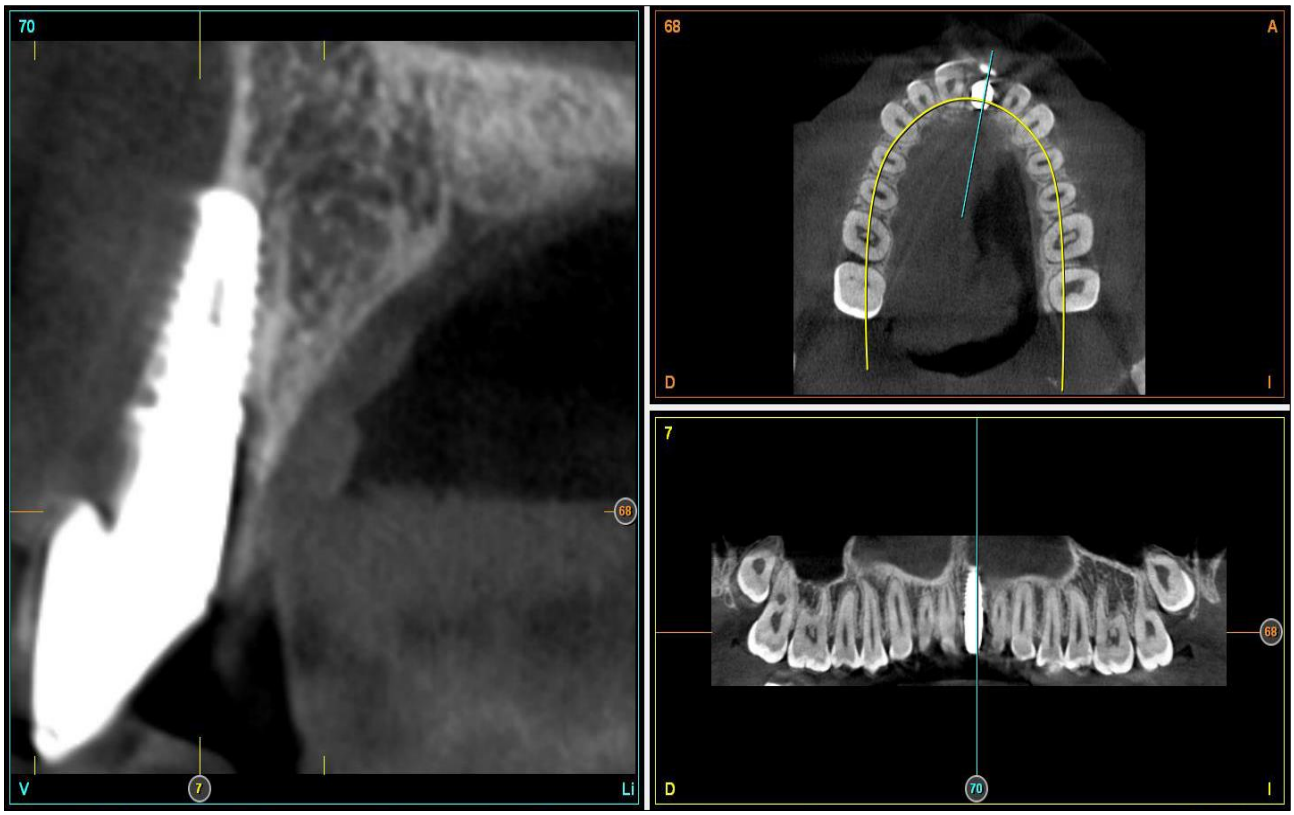


Figure 6: Cone-beam computed tomography cross-sectional image showing the implant incorrectly positioned within the residual bone, with excessive buccal inclination

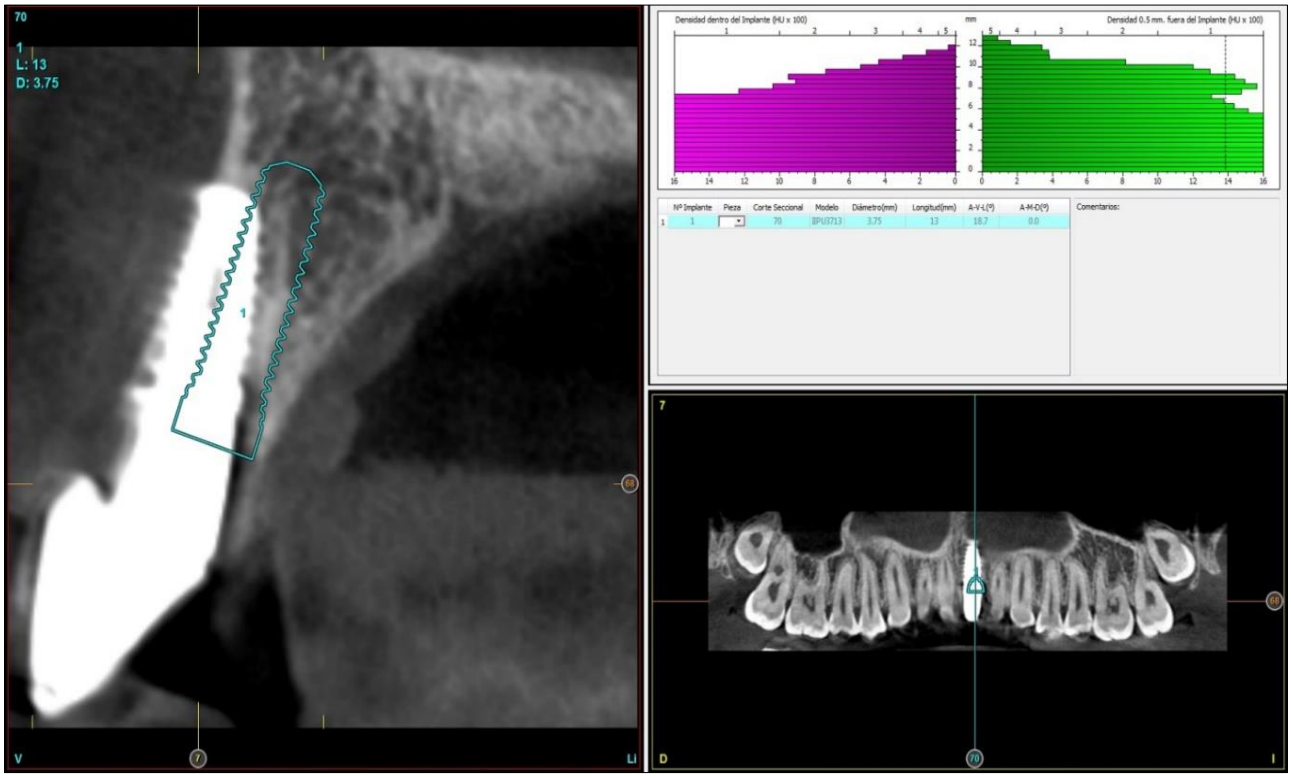


Figure 7: Planning of the new implant to be placed immediately in the post-explantation site, in the correct position



Figure 8: Implant and crown following atraumatic explantation

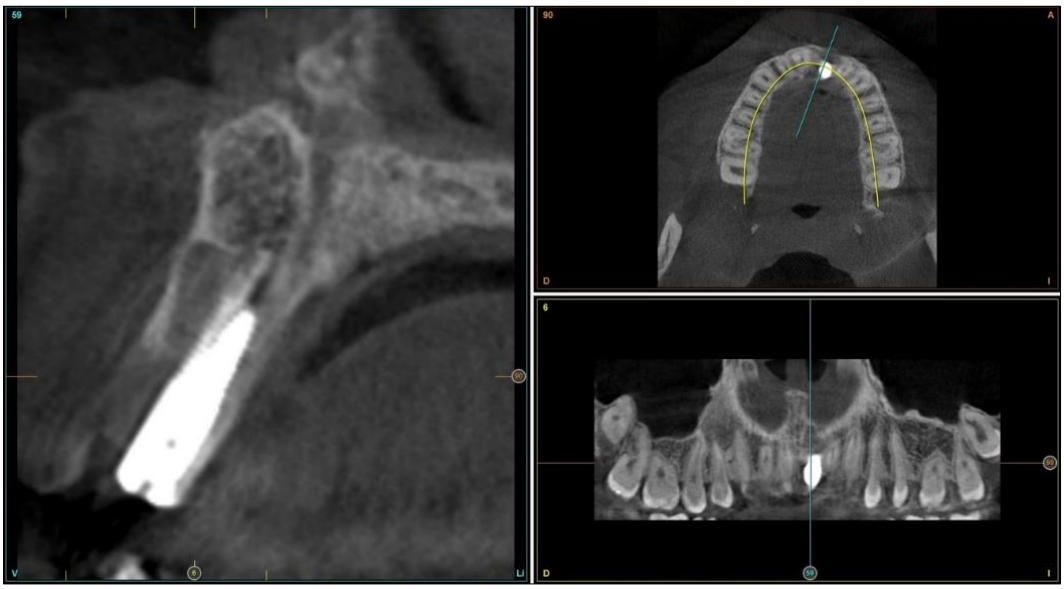
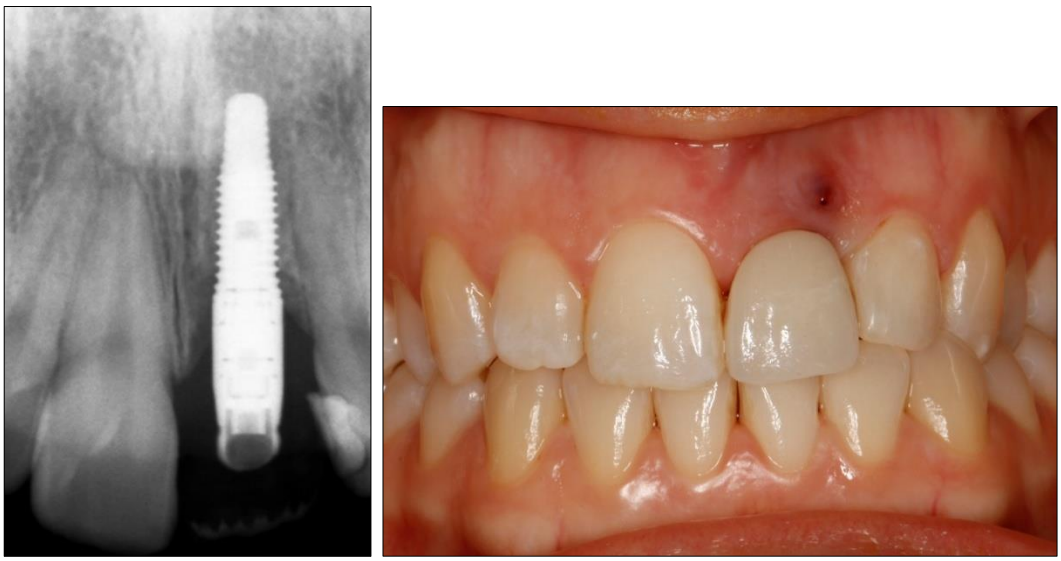
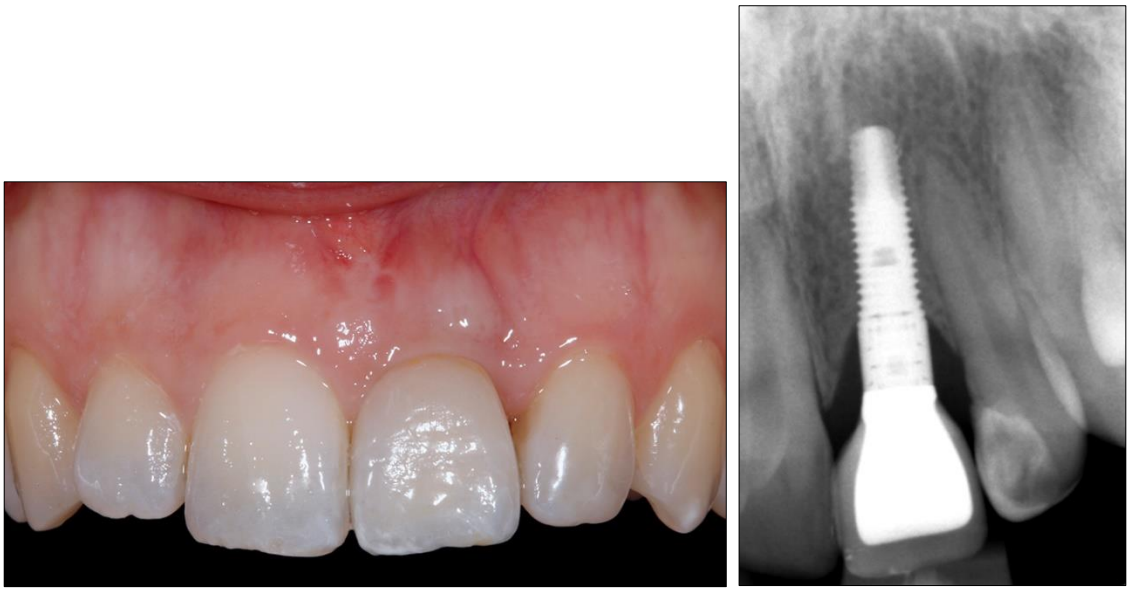


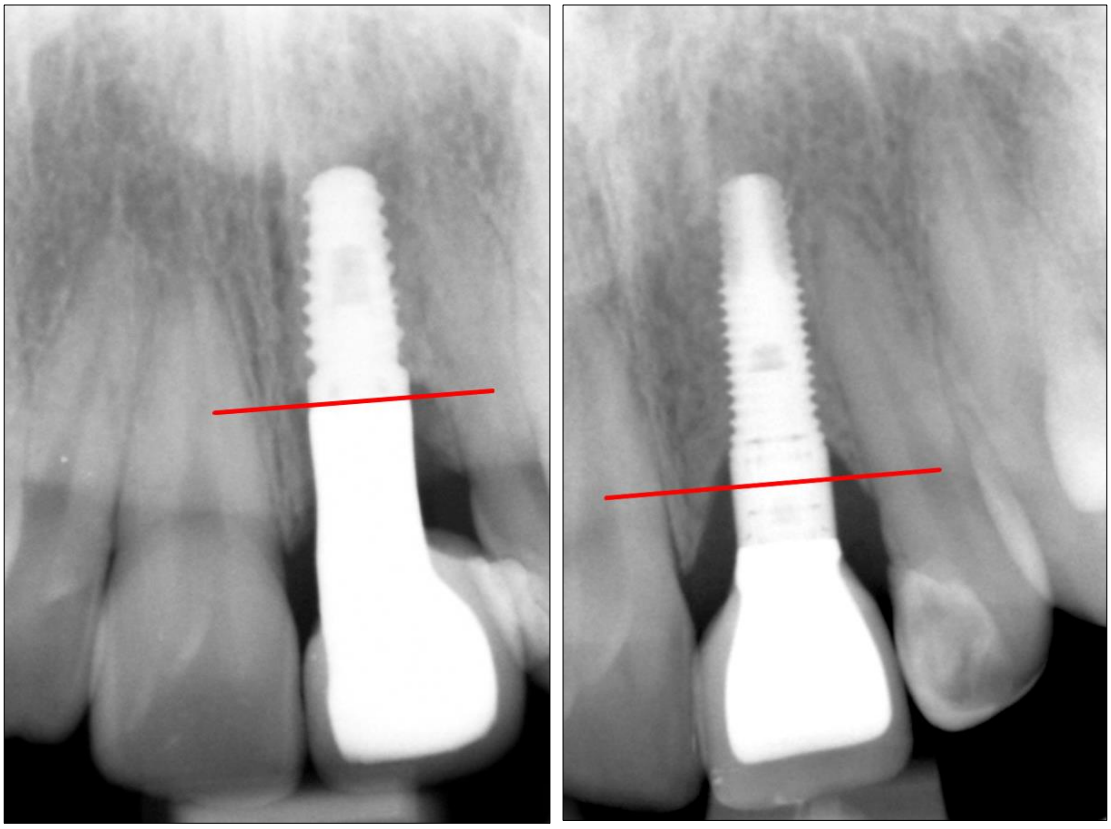
Figure 9: New implant in the correct position after removal of the malpositioned implant and filling of the residual gap with autologous bone harvested during drilling and soaked in PRGF-Endoret



Figures 10 and 11: Immediate-loading provisional restoration following implant placement. As shown, a screw-retained resin crown was fabricated on a single-unit transepithelial abutment (Unit®). The provisional restoration does not exert pressure on the soft tissues, allowing their healing and remodeling



Figures 12 and 13: Definitive crown after ten years of follow-up, also screw-retained on a single-unit transepithelial abutment, in this case fabricated from metal-ceramic



Figures 14 and 15: Comparison of the initial and final positions of the removed and newly placed implants following explantation, showing the correct apicocoronal positioning of the replacement implant in relation to the cementoenamel junctions of the adjacent teeth

DISCUSSION

The main finding of the present study is the high long-term predictability of immediate replacement of previously failed single implants in the aesthetic zone using an atraumatic explantation technique. All 36 replacement implants remained in function at the end of follow-up, with a survival rate of 100% after a mean period of 10.67 ±0.72 years. This finding is particularly relevant because the study involved exclusively single-tooth rehabilitations in the anterior maxilla, where the prognosis of retreatment depends not only on the osseointegration of the new implant but also on the ability to maintain a tissue architecture compatible with

an aesthetically and functionally satisfactory restoration [6-36].

One of the main contributions of the present study is demonstrating that immediate replacement of a previously failed implant can provide favourable outcomes beyond the first decade of function, even in a particularly demanding anatomical location such as the anterior aesthetic zone. Unlike previous series, which combined different anatomical locations, rehabilitation modalities and reimplantation protocols, the present investigation exclusively analysed single implants replaced during the same surgical procedure as explantation [32-42]. This homogeneity allows a more specific assessment of the long-term behaviour of a retreatment strategy that, until now, has mainly been investigated in heterogeneous populations and over considerably shorter observation periods. Nevertheless, the 100% survival rate observed in our sample should not be interpreted as evidence of superiority over other protocols, but rather as evidence that, in appropriately selected cases, immediate reimplantation may represent a clinically viable and stable long-term alternative, without failure of the initial implant necessarily determining the prognosis of the subsequent treatment.

Another relevant finding is the limited marginal bone loss observed after more than a decade of function. Measurements performed at the end of follow-up showed mean values of 0.61 ±0.20 mm mesially and 0.55 ±0.17 mm distally, with an overall mean marginal bone loss of 0.58 mm. These results indicate that the placement of a new implant in a site previously occupied by another implant, even when removal was due to a biological complication, was not necessarily accompanied by progressive marginal bone loss of clinically relevant magnitude during the period evaluated. Furthermore, mesial and distal bone loss values were lower than those reported by our research group in a series of immediate reimplantation following peri-implantitis, in which values of 0.89 ±0.62 mm and 0.97 ±0.66 mm were recorded, respectively [38]. However, this comparison should be interpreted with caution because of methodological differences and variations in follow-up between the two studies, as well as the inclusion of multiple anatomical locations.

From a clinical perspective, it is particularly noteworthy that peri-implantitis was the main indication for explantation, accounting for 58.3% of cases. A history of peri-implant disease may raise concerns regarding the prognosis of placing a new implant in the same site because of bone destruction and inflammatory changes in the surrounding tissues [41–45]. However, in this series, implants placed immediately after the removal of implants affected by peri-implantitis remained in function until the final follow-up examination. This finding suggests that a history of peri-implantitis does not, in itself, constitute an absolute contraindication to immediate reimplantation, provided that the anatomical conditions of the recipient site, removal of pathological tissue and primary stability of the new implant allow the procedure to be performed. Nevertheless, it should be noted that the study did not include a specific analysis of the evolution of the initial bone defects or a statistical comparison of outcomes according to the reason for explantation. Therefore, it cannot establish whether the prognosis was equivalent in cases of peri-implantitis and implant malposition.

Implant malposition was the second most frequent reason for explantation, occurring in 38.9% of patients. This subgroup is particularly important in the aesthetic zone, as an implant may remain osseointegrated while occupying a position that is incompatible with a satisfactory restoration [46, 47]. Under these circumstances, explantation does not necessarily result from biological failure, but rather from the inability to adequately correct the consequences of an unfavourable three-dimensional position using exclusively prosthetic or mucogingival procedures. Conservative implant removal allows the position of the new implant to be reconsidered according to the requirements of the definitive restoration [44-48]. The clinical case presented in the study figures illustrates this possibility, showing the replacement of an implant with excessive buccal inclination and an inadequate apicocoronal position by another implant placed in a more favourable position for rehabilitation. However, as no objective aesthetic indices or dimensional measurements of the soft tissues were recorded, the aesthetic improvement should be regarded as an illustrative clinical observation rather than a quantified outcome for the entire sample.

The possibility of completing explantation without trephine drilling in any of the 36 cases is another noteworthy aspect. Although this finding may be related to the ability of counter-torque to disengage the implant without performing a circumferential osteotomy, it should be interpreted in the context of a selected sample in which immediate placement of a new implant was possible. The absence of additional bone removal procedures is particularly relevant when the objective is to reuse the recipient site, although it does not allow direct quantification of the bone volume preserved [45-49].

The dimensional modifications of the replacement implants provide information regarding the surgical adaptation of the post-explantation site. In all cases, an implant with a larger diameter than the removed implant was used, whereas implant length was maintained or increased according to the available anatomical conditions. This strategy may facilitate contact between the new implant and areas of remaining bone and contribute to achieving primary stability, particularly when the interface previously occupied by the explanted implant has a geometry that does not allow the conditions of a conventional osteotomy to be reproduced exactly [32-50]. Nevertheless, an increase in

implant dimensions should not be considered a universal requirement for immediate reimplantation, as the selection of the new implant must depend on bone availability, the prosthetically planned position and the proximity of anatomical structures. In the anterior region, indiscriminately increasing implant diameter could compromise the thickness of the buccal bone wall. Therefore, implant selection should aim to achieve primary stability without sacrificing the bone volume required to maintain the peri-implant tissues [51–53].

Regarding the need for additional procedures, only six patients (16.7%) required the placement of particulate autologous bone harvested during drilling to fill residual gaps between the new implant and the walls of the recipient site. In the remaining 30 cases (83.3%), this procedure was not required. This finding suggests that, in selected cases, conservative explantation and dimensional adaptation of the new implant allowed immediate replacement without systematically requiring the filling of residual defects.

The choice of a two-stage surgical protocol is another factor that should be considered when interpreting the results. Although the new implant was placed immediately after explantation, prosthetic rehabilitation was performed in most cases after the corresponding healing period. Therefore, the findings of this series should be attributed to an immediate reimplantation protocol with delayed loading and should not be directly extrapolated to immediate loading or provisionalisation procedures. This distinction is particularly important in the anterior region, where the provisional restoration may play a relevant role in maintaining the mucosal contour but may also introduce additional biomechanical demands during osseointegration [54–57].

CONCLUSIONS

The 100% survival rate, together with a mean marginal bone loss of less than 0.6 mm, supports the long-term feasibility of this therapeutic alternative in appropriately selected patients. These findings suggest that the removal of a previously failed implant does not necessarily require delaying subsequent implant rehabilitation, provided that an adequate recipient site can be preserved and a three-dimensional position and primary stability compatible with the planned treatment can be achieved. Future prospective comparative studies incorporating three-dimensional assessment of hard and soft tissues and standardised aesthetic parameters will help determine more precisely the indications and benefits of this strategy in the aesthetic zone.

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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