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Treatment Protocol for the Fully Edentulous Mandible with Implant-Supported Hybrid Prosthesis on Four Implants: "Full on Shorts®" Concept, Case Series

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Abstract

Introduction: Rehabilitation of the edentulous mandible with severe atrophy remains a major clinical challenge in implant dentistry. Conventional regenerative procedures, while effective, involve high morbidity, long treatment times, and increased costs. To overcome these limitations, the "Full on Shorts®" protocol was developed, based on the placement of short and extra-short implants in posterior mandibular positions, distributed vertically and parallel to minimize cantilevers and optimize biomechanical stability without the need for regenerative surgery or tilted implants. ***Materials and Methods:*** This retrospective study included patients treated with the "Full on Shorts®" protocol and followed for a minimum of two years after implant loading. Four implants were placed in each edentulous mandible using a biological drilling protocol. All cases received immediate loading with provisional prostheses, followed by definitive prostheses after 3–4 months. Clinical and radiographic follow-up was conducted every six months, with marginal bone loss evaluated using standardized periapical radiographs. Primary outcomes were implant and prosthesis survival, insertion torque, and marginal bone changes. ***Results:*** A total of 36 implants were placed in 9 patients (mean age 64.9 ± 7.3 years). Mean alveolar crest height at implant sites was 6.57 ± 0.63 mm. The average insertion torque was 47.2 ± 13.2 Ncm, with higher values in type I bone (50.3 Ncm) compared to type III bone (37.5 Ncm). All implants were immediately loaded. After a mean follow-up of 39.1 ± 13.3 months (range 20–67), the survival rate of both implants and prostheses was 100%. Mean marginal bone loss was minimal, with 0.21 ± 0.49 mm mesially and 0.13 ± 0.48 mm distally. Only two minor prosthetic complications (screw loosening) were recorded. ***Conclusions:*** The "Full on Shorts®" protocol represents a reliable and minimally invasive approach for the rehabilitation of atrophic mandibles. The excellent implant and prosthesis survival, combined with negligible marginal bone loss and the feasibility of immediate loading, support this technique as a predictable alternative to conventional regenerative or tilted implant protocols.

Keywords: Dental Implants, Prosthetics, Surgical/Clinical Concepts, implant loading, immediate loading.

INTRODUCTION

Implant-supported rehabilitation of the edentulous mandible with moderate or severe atrophy remains one of the greatest challenges in oral implantology. Traditionally, the loss of bone support after long periods of edentulism required consideration of advanced regenerative techniques such as block bone grafts, guided bone regeneration, or osteogenic distraction that, although effective, involve high morbidity, greater costs, prolonged treatment times, and an increased risk of postoperative complications [1,5]. In this context, current trends have shifted toward simplified surgical protocols that allow for fixed rehabilitations while avoiding extensive regenerative procedures.

The All-on-4 protocol emerged as an alternative in mandibular atrophy, proposing the placement of four implants, two anterior and two posterior tilted up to 30–45°, in order to avoid proximity to the inferior alveolar nerve and to maximize anchorage in the anterior cortical bone [7,8]. This strategy reduces the need for grafting and enables immediate rehabilitation with fixed prostheses, which has

consolidated its worldwide popularity. However, the inclination of the distal implants generates a pattern of stress concentration at the bone–implant interface and in the prosthetic cantilever area, which may compromise long-term biomechanics [9,11].

Several finite element analysis studies have shown that load distribution in mandibular All-on-4 configurations concentrates higher stress on distal implants and crestal cortical bone, with a potential risk of mechanical overload and technical complications [10,11]. Although these risks may be minimized with proper planning and optimized prosthetic design, they remain an intrinsic limitation of the technique. The introduction of short and extra-short implants has opened new possibilities in the atrophic mandible. These implants make it possible to avoid large angulations and, in many cases, obviate complex regenerative procedures. When placed vertically, they provide more favorable biomechanics, with axial load transmission and reduced marginal stress [12,13]. Clinical evidence accumulated over the last decade supports the efficacy and survival of short implants in posterior mandibular regions, even under limited bone height conditions, with success rates comparable to conventional implants [14,15].

Considering the predictability of short implants, their versatility, and the possibility of placing them in atrophic areas without angulation, we developed a new rehabilitation protocol for the fully edentulous mandible. In cases where only four implants can be placed, our approach consists of distributing them homogeneously across the mandible to minimize cantilevers and lever arms, thus generating biomechanically stable prostheses using short and extra-short implants placed directly without the need for angulation. This new concept, called “FULL ON SHORTS®”, is based on the use of short implants to support prosthetic rehabilitation in mandibular atrophy.

The protocol relies on a set of surgical and prosthetic considerations aimed at optimizing biomechanical behavior and treatment longevity. First, rehabilitation is planned using a complete non-segmented prosthesis, with implants placed vertically to avoid complications associated with excessive inclination. Posterior implants are inserted as distally as possible, without exceeding limits that could compromise the physiological flexibility of the mandible or generate undesirable stress. Likewise, distal cantilever is minimized by adjusting prosthetic design, even if it requires shortening the arch extension or eliminating teeth in the planning phase, with the goal of ensuring a proper balance between function, esthetics, and biomechanical stability.

In this study, we present a series of clinical cases rehabilitated with this protocol, evaluating treatment success, implant and prosthesis survival, and crestal bone loss.

MATERIALS AND METHODS

Patients who had undergone the rehabilitation protocol described above, with at least two years of follow-up after loading, were retrospectively recruited.

Before surgery, antibiotic prophylaxis with amoxicillin (2 g, orally) was administered one hour prior to the procedure, accompanied by paracetamol (1 g) as an analgesic. Postoperatively, amoxicillin (500–750 mg every 8 hours, adjusted to body weight) was prescribed for five days. Preoperative preparation included study models, comprehensive intraoral clinical examination, and cone-beam computed tomography (CBCT). These radiographic records were analyzed using specific software (BTI-Scan III, Biotechnology Institute, Spain).

All surgeries were performed by a single surgeon using the biological drilling protocol at low revolutions[16]. The entire procedure was carried out under local anesthesia with vasoconstrictor. Primary closure was achieved with non-resorbable monofilament sutures (5/0), which were removed 10–15 days later.

In all cases, immediate loading was performed. The initial prosthesis was fabricated without distal extension and made of more flexible materials, such as resin and prefabricated bar structures. Patients attended a 15-day postoperative check for suture removal and were subsequently followed clinically and radiographically. After 3–4 months of initial loading, the definitive prosthesis was fabricated. Once the implants received functional load and bone bed densification occurred, distal cantilever was slightly increased. The definitive prosthesis was fabricated with a CAD-CAM structure, with a slight distal extension, and was always screw-retained via multiple transepithelials. In some cases, an intermediate progressive-load prosthesis with greater distal extension was provided depending on implant position.

After delivery of the definitive prosthesis, patients were monitored to evaluate implant and prosthesis performance. Postoperative follow-up included clinical and radiographic evaluations every six months. Radiographic follow-up consisted of standardized panoramic and periapical radiographs, which allowed assessment of implant stability and marginal bone changes.

Periapical radiographs were obtained using positioners designed to maintain a constant incidence angle and focal distance. For panoramic radiographs, standardization included anatomical and positioning references: simultaneous support of glabella and chin, bite block in the interincisal area, alignment of Frankfurt and bipupillary planes using laser guides, and controlled foot placement on floor markers. These measures ensured that images obtained at each control were comparable and reproducible.

Digital processing of the images was performed with ImageJ software (National Institutes of Health, Bethesda, MD, USA). To correct radiographic magnification, the real length of the implant was used as calibration scale, allowing precise linear measurements after automatic correction by the software.

Marginal bone resorption was determined by measuring the distance between the implant shoulder and the first visible bone–implant contact. Variables analyzed included implant survival, marginal bone loss (mesial and distal), and prosthesis survival according to established criteria. Survival analysis was performed using the Kaplan–Meier method, and statistical analysis was conducted with SPSS v15.0 (SPSS Inc., Chicago, IL, USA).

Prosthesis survival at the end of follow-up was also estimated according to the criteria proposed by Misch *et al.,* and Albrektson *et al.,* [17,19]. A prosthesis was considered "surviving" if it:

- Remained in function throughout the follow-up period without removal due to failure.
- Presented no detectable mobility.
- Did not require complete replacement due to mechanical or biological complications.
- Provided adequate masticatory function, esthetics, and phonetics according to clinical evaluation.
- Showed no clinical signs of active infection or progressive bone loss compromising function.

Minor complications such as screw loosening, ceramic fractures, or occlusal wear were recorded but were not considered prosthesis failures if they could be resolved without complete replacement.

RESULTS

A total of 9 patients who underwent the described therapeutic protocol were recruited, and 36 implants were placed. Six of the nine patients were women, with a mean age of 64.9 (± 7.32) years. In each patient, four implants were placed in the edentulous mandible, distributed in positions 3–6 in five patients (20 implants), positions 2–4 in three patients (12 implants), and positions 3–5 in one patient (4 implants), as shown in Figure 1.

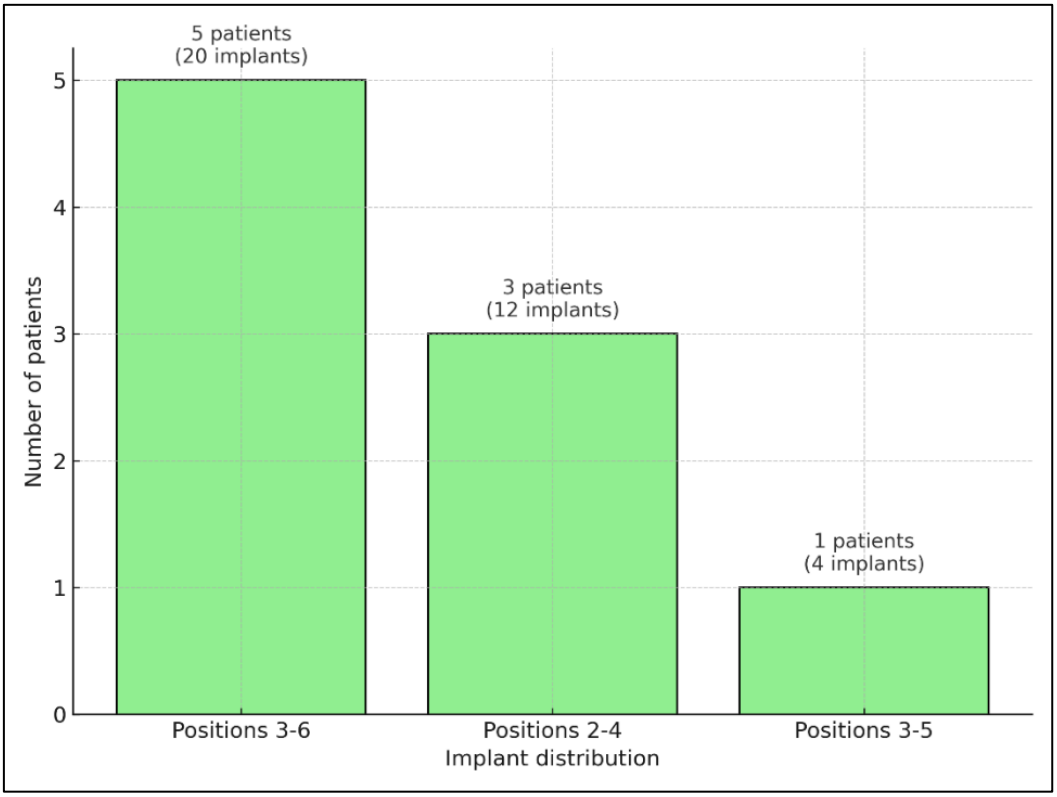


Figure 1: Distribution of implant positions included in the study. As shown, the most frequent and biomechanically favorable position is 3–6, although there are cases of 2–4 and one of 3–5. This variability can be explained by the severe atrophies present in the mandibles treated with this approach, where implant positions sometimes need to be adapted

The mean alveolar ridge height at the implant sites was 6.57 mm (± 0.63), with a range of 5–7.5 mm. Implant lengths ranged from 4.5 to 6.5 mm. Figure 2 illustrates the initial bone height in each case and the length of the implant placed, stratified by patient.

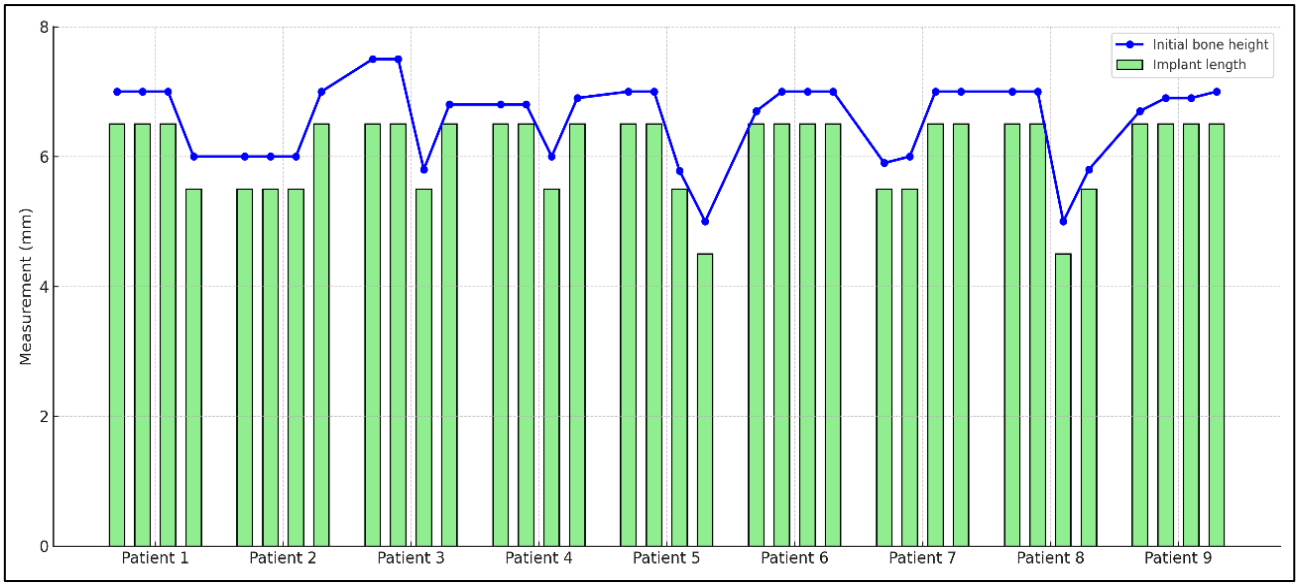


Figure 2: Length of each implant according to residual bone height, categorized by implant and patient. The residual bone volume was maximally utilized, with very little discrepancy between the total available site and the implant length, given that these cases involved pronounced vertical atrophy

The implant diameter ranged from 3 mm to 4 mm, with 3.5 mm being the most frequent, indicating that many cases presented a mixed atrophy pattern (vertical + horizontal). All diameters and lengths are presented in Figure 3.

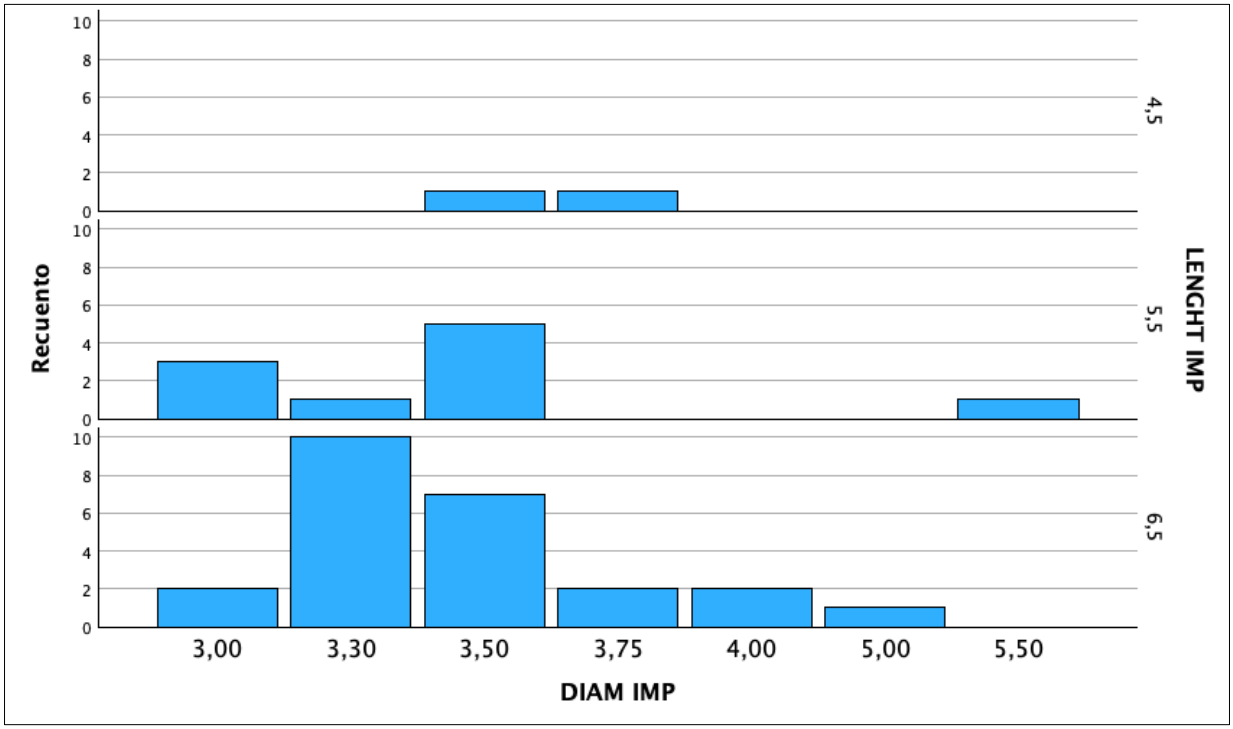


Figure 3: Diameters and lengths of the implants included in the study. Most implants ranged from 3.0 to 3.5 mm in diameter, indicating that, in addition to vertical atrophy, horizontal bone deficiency was also predominant

Bone quality at the surgical sites was predominantly type I in 44.4% of the implants. The mean insertion torque was 47.22 Ncm (± 13.22). The distribution of insertion torque according to bone type is shown in Figure 4. Mean torque values differed among bone types: type I bone, 50.3 Ncm (± 12.3; n=16); type II bone, 49.6 Ncm (± 11.4; n=12); and type III bone, 37.5 Ncm (± 14.4; n=8). Immediate loading was performed in all 9 patients. Provisional prostheses were maintained for a mean of 4.9 months (± 0.7).

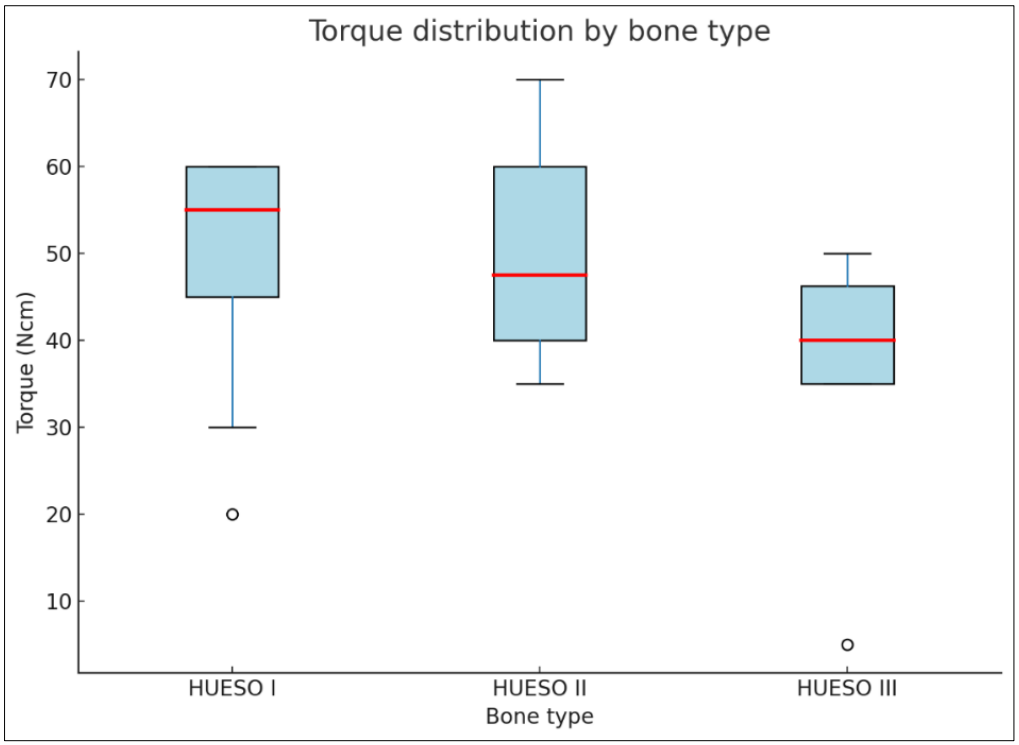


Figure 4: Distribution of insertion torque according to bone type. As expected, the highest mean values were observed in type I bone due to its greater density. Nevertheless, adequate primary stability was achieved for extra-short implants across all bone types

The mean follow-up time for implants was 39.1 months (± 13.36), ranging from 20.2 to 67 months. During this period, no implant failures were recorded (100% survival), and prosthesis survival, according to the criteria of Misch *et al.,* and Albrektson *et al.,* [17,19] was also 100%. Only two minor incidents of screw loosening were recorded in two cases. The mean marginal bone loss at the end of the follow-up period was 0.21 mm (± 0.49) at the mesial surface and 0.13 mm (± 0.48) at the distal surface. One of the cases included in the study is shown in Figures 5–21.

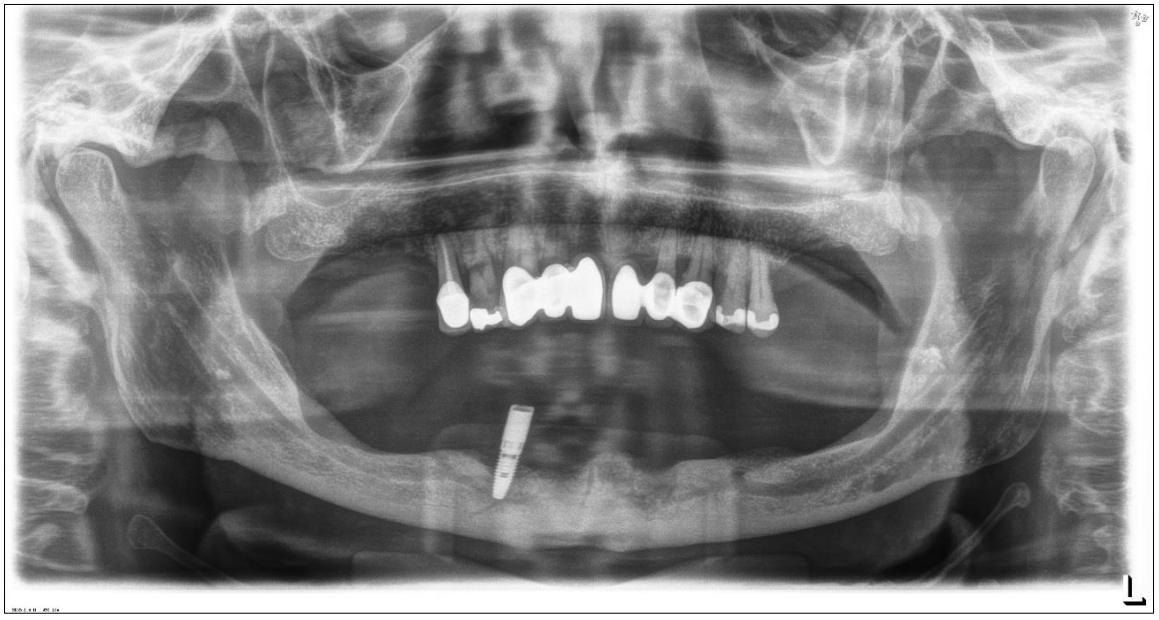


Figure 5: Baseline radiograph of the case showing that the patient had previously undergone mandibular rehabilitation with implants, all of which had failed except for one, leaving circumferential bone defects. The remaining implant also required extraction due to advanced peri-implantitis

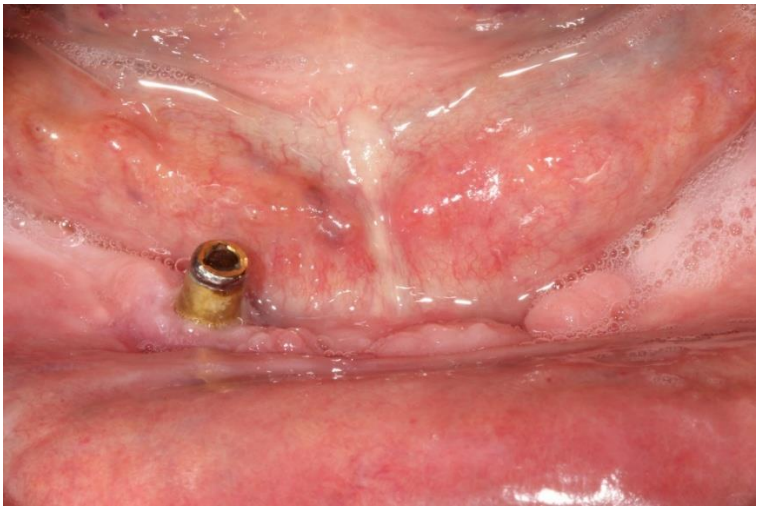
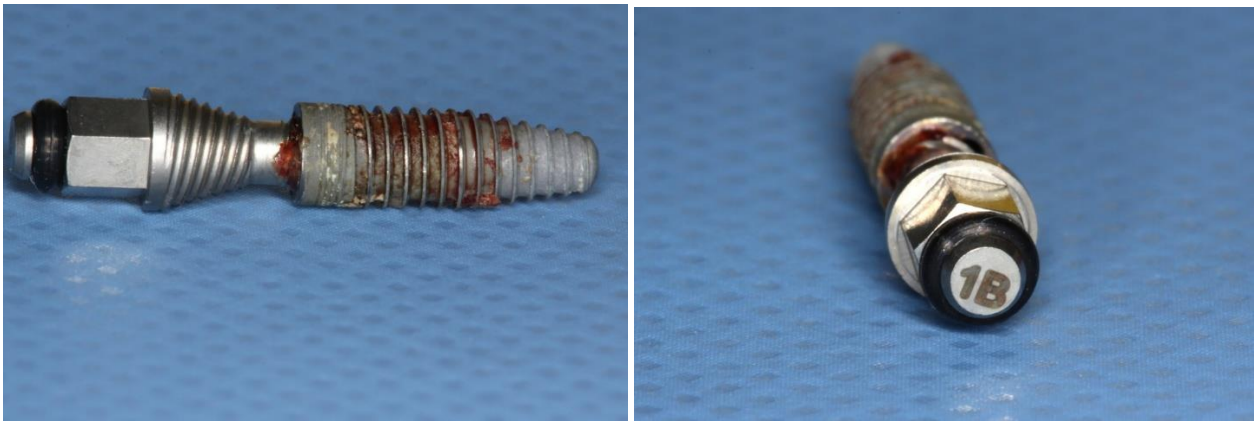
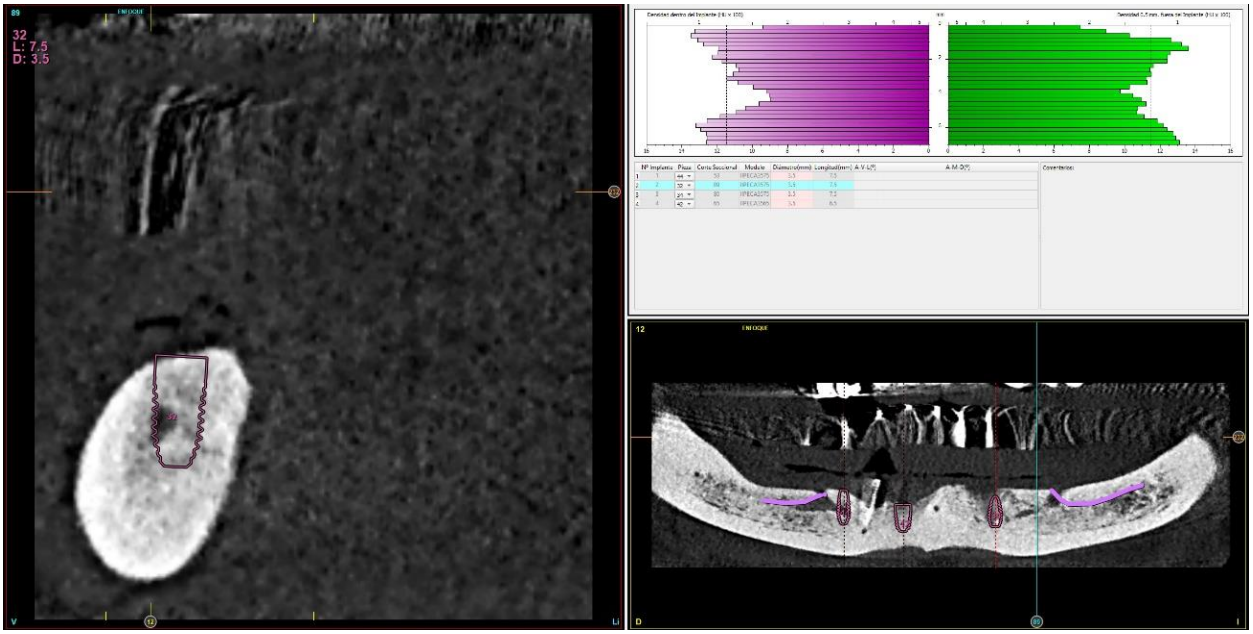
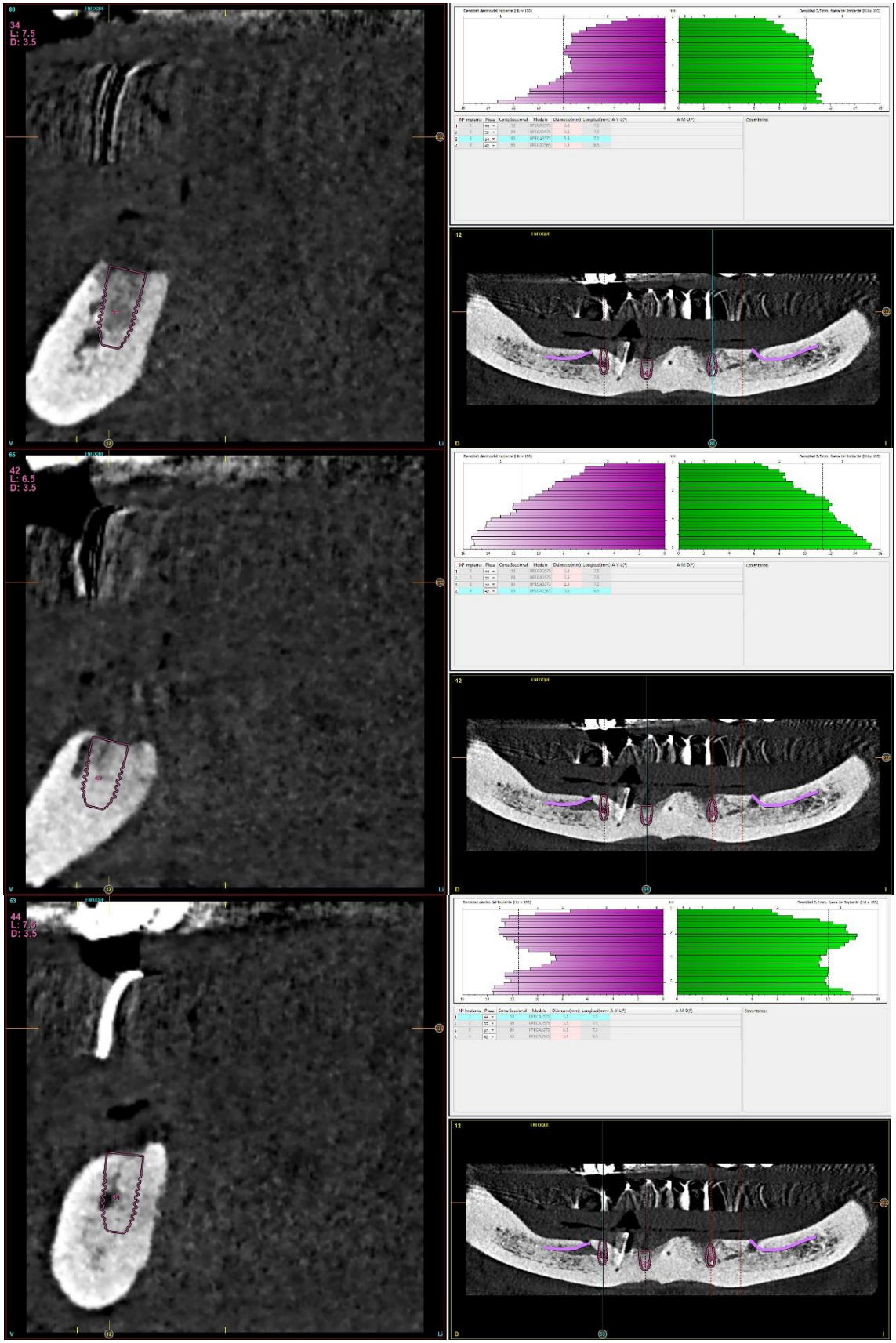


Figure 6: Intraoral situation of the patient showing the ridge defect, already visible to the naked eye

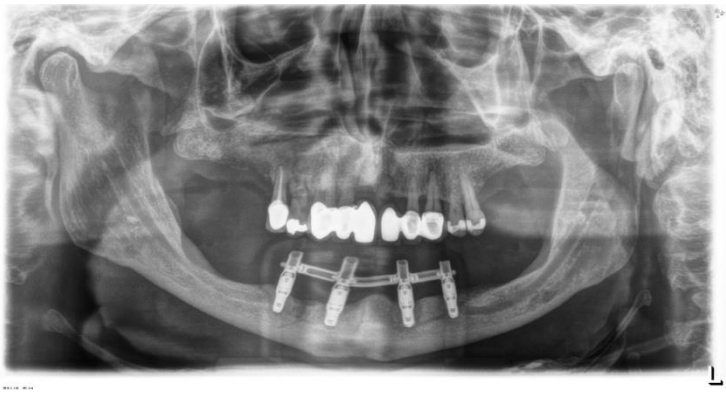


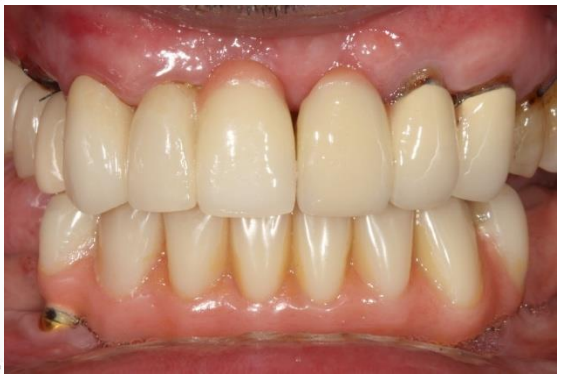
Figures 7–8: Atraumatic explantation using the implant extraction kit (KEXIM® – Biotechnology Institute), preserving the remaining bone bed, which allowed for new implants to be placed in the same area during the same surgery





Figures 9–12: Planning of the new implants, which were inserted during the same surgery as the explantation. As shown, biomechanical considerations required that the most distal implant in the fourth quadrant be positioned differently from the extracted one





Figures 13–14: Immediate loading of the implants without distal extension, using a framework of articulated bars screwed onto transepithelial abutments, as described in the protocol

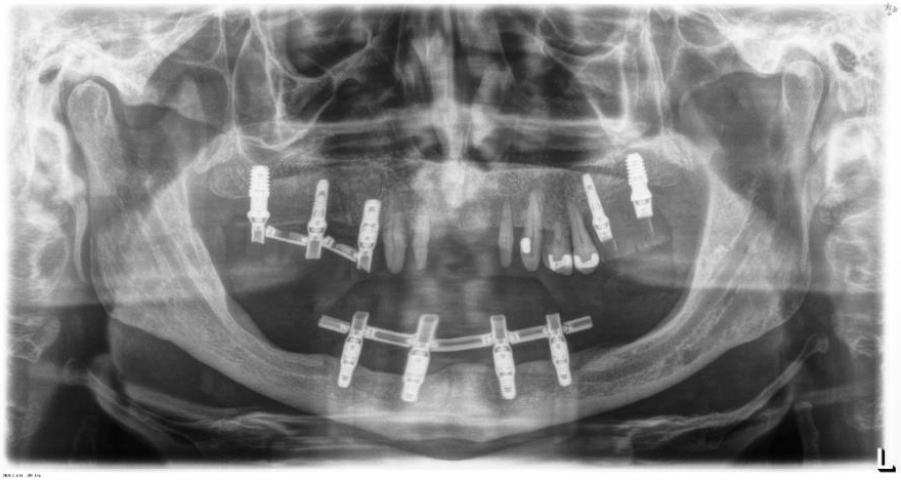


Figure 15: In this case, with implants distributed in positions 3–5, a second set of provisional prostheses was fabricated with greater distal extension, aiming to progressively increase the cantilever while simultaneously enhancing densification of the remaining alveolar ridge

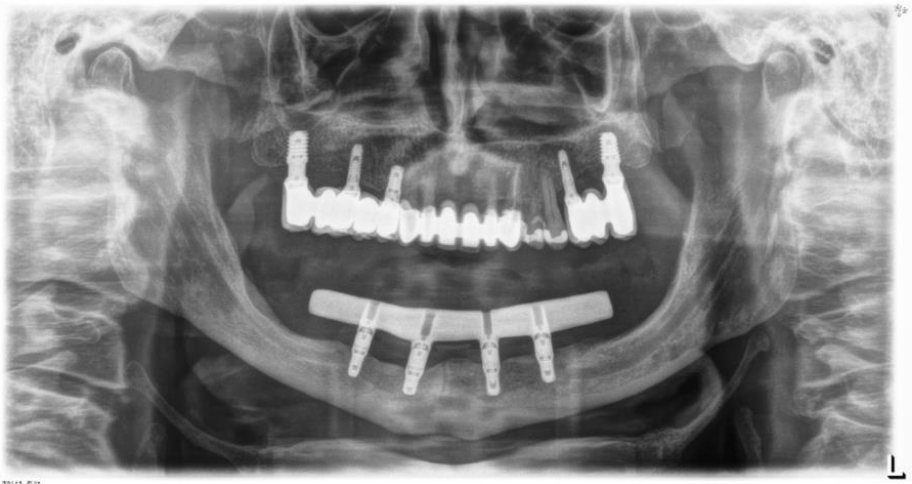


Figure 16: Definitive prosthesis after two years of loading. This prosthesis was placed three months after the second set of provisionals with extended structure. The radiograph shows evident bone reinforcement of the mandible resulting from the distributed occlusal loading transmitted through the implants

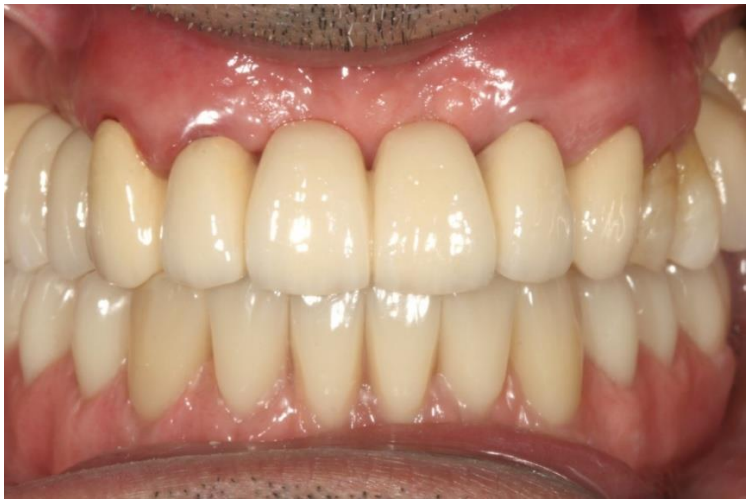
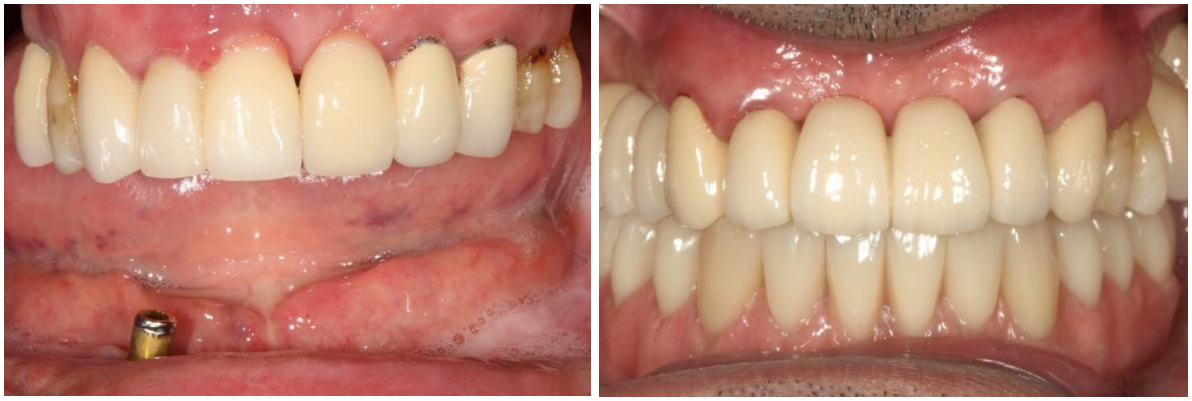
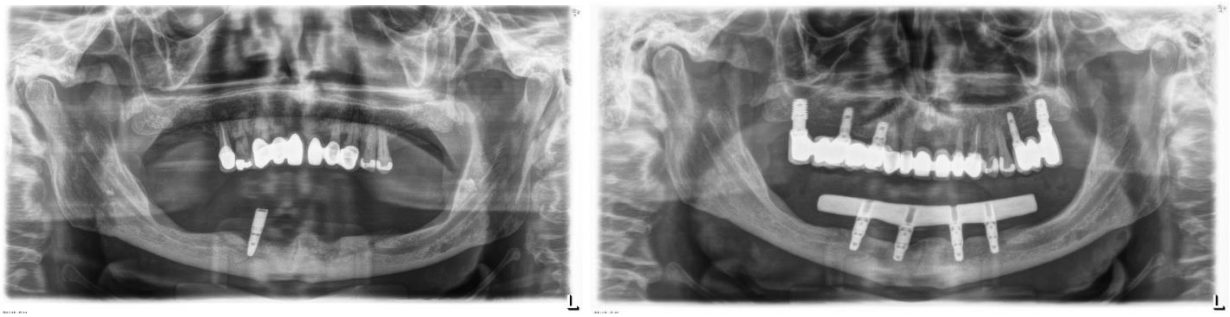


Figure 17: Definitive prosthesis at the time of placement



Figures 18–19: Initial and final comparison of the mandibular prosthesis and the replacement of the maxillary rehabilitation. Both demonstrate improved esthetics and the restoration of proper occlusion



Figures 20–21: Comparison of baseline and final radiographs after five years of follow-up with the definitive prosthesis (three years from the start of loading). The images clearly show regeneration of the initial defects and increased mandibular body width with implant-supported prostheses

DISCUSSION

The results of this study demonstrate that mandibular rehabilitation with extra-short implants is a highly predictable option in cases of severe vertical atrophy. The 100% survival rate of implants and prostheses over a mean follow-up of 39.1 months confirms that, when rigorous surgical protocols and appropriate prosthetic design are applied, this approach can achieve clinical outcomes comparable to those of conventional implants placed in more favorable anatomical conditions [20,22].

A key aspect of this research is that the applied strategy is based on the "full-on-shorts" concept, i.e., the use of extra-short implants in posterior positions, thus avoiding the need for highly morbid regenerative techniques or the placement of tilted implants as in the All-on-4 protocol. Positioning distal implants without angulation provides biomechanical advantages compared to tilting the terminal implant, as it maximizes the support surface and reduces cantilever effects. The use of this parallel short-implant protocol allows for more axial loading, simplifies surgery, and reduces the

risk of biomechanical complications associated with oblique forces [12,13,23].

This approach also offers several advantages over regenerative protocols, which would otherwise be the next therapeutic alternative after tilted implants. First, it eliminates the need for bone grafts or guided bone regeneration, reducing surgical time, cost, and potential intra- and postoperative complications[24]. Second, it allows patients to undergo a less invasive rehabilitation with shorter treatment times, thereby improving treatment acceptance. These benefits complement the high predictability observed in the present study, where marginal bone resorption was minimal (0.21 mm mesial, 0.13 mm distal), values well below the thresholds accepted in modern implant dentistry [25,26].

Analysis of insertion torque confirmed the influence of bone quality on primary stability, with higher mean values in type I bone (50.3 Ncm) and lower values in type III bone (37.5 Ncm). Nevertheless, even in low-density bone, sufficient stability was achieved to permit immediate loading in all patients (6 out of 9 cases), reinforcing the feasibility of this protocol. The use of splinted provisional prostheses without distal extension may have contributed to favorable load distribution during the initial healing phase, promoting progressive densification of the alveolar ridge prior to delivery of the definitive prosthesis [27].

Moreover, most implants used in this study had reduced diameters (3.0, 3.3, and 3.5 mm), reflecting the presence of mixed atrophy (vertical and horizontal) in the treated patients. Despite this anatomical limitation, the outcomes were excellent, with no implant failures and only two minor prosthetic complications (screw loosening). This clinical performance aligns with recent literature supporting the efficacy of extra-short implants, provided biomechanical planning principles are respected, such as rigid splinting of prostheses and minimization of cantilevers [28,30]

CONCLUSIONS

The results of this study demonstrate that the "full-on-shorts" protocol, based on the placement of extra-short implants in posterior positions to avoid implant angulation, represents an effective and minimally invasive therapeutic alternative for mandibular rehabilitation in cases of severe bone atrophy. The 100% survival rate of both implants and prostheses after more than three years of follow-up, together with virtually negligible marginal bone loss, confirms the reliability of this approach.

Furthermore, the primary stability achieved across different bone types allowed the application of immediate loading protocols in most cases. This model avoids the need for complex regenerative procedures and simplifies surgery, offering highly predictable clinical outcomes and long-term biomechanical stability.

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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