OPEN ACCESS

Saudi Journal of Oral and Dental Research

Abbreviated Key Title: Saudi J Oral Dent Res
ISSN 2518-1300 (Print) | ISSN 2518-1297 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article **Oral Implantology**

Crown-To-Implant Ratio ≥3 in Extra-Short Narrow-Diameter Implants: A Retrospective Study

Eduardo Anitua DDS, MD, PhD[1,2,3]*

[1]Private Practice in Oral Implantology, Eduardo Anitua Institute, Vitoria, Spain
[2]Clinical Researcher, Eduardo Anitua Foundation, Vitoria, Spain
[3]University Institute for Regenerative Medicine and Oral Implantology - UIRMI (UPV/EHU-Fundación Eduardo Anitua), Vitoria, Spain

DOI: https://doi.org/10.36348/sjodr.2026.v11i05.008 | **Received:** 19.03.2026 | **Accepted:** 14.05.2026 | **Published:** 22.05.2026

***Corresponding author:** Eduardo Anitua
Private Practice in Oral Implantology, Eduardo Anitua Institute, Vitoria, Spain

Abstract

Introduction: The relationship between implant length and prosthetic crown height has traditionally been considered a critical factor in the biomechanical stability of implant-supported restorations. High crown-to-implant ratios (CIR) have been associated with increased stress at the bone–implant interface and potential risk of failure. However, recent evidence suggests that this parameter may have a limited clinical impact when other factors are properly controlled. The aim of this study was to retrospectively evaluate the clinical performance of extra-short, narrow-diameter implants placed in situations with crown-to-implant ratios ≥3. ***Materials and Methods:*** A retrospective study was conducted including patients treated in 2020 with extra-short implants (4.5–6.5 mm) and narrow diameters (3–3.5 mm), supporting single or fixed restorations. All cases had a minimum follow-up of five years. Treatment planning was performed using CBCT and digital software, allowing individualized surgical protocols to optimize primary stability. Clinical and radiographic follow-up included periodic periapical radiographs. Implant survival was assessed using Kaplan-Meier analysis, and marginal bone loss was measured using calibrated digital images. ***Results:*** Six patients with 24 implants were included, with a mean follow-up of 62.6 ± 7.8 months. The mean crown-to-implant ratio was 3.27 ± 0.26 (range 3–3.9). Implant survival was 100%, with no failures recorded. Prosthetic survival was also 100%, although seven minor technical complications were observed, mainly screw loosening. Mean marginal bone loss was 0.42 ± 0.59 mm (mesial) and 0.45 ± 0.70 mm (distal). Most implants were immediately loaded and restored with screw-retained prostheses. ***Conclusions:*** Extra-short, narrow-diameter implants placed in situations with crown-to-implant ratios ≥3 can achieve favorable medium-term clinical outcomes. Implant survival and marginal bone stability appear to depend more on biomechanical and biological factors than on the magnitude of the crown-to-implant ratio itself. These findings suggest that high CIR values should not be considered a limiting factor when appropriate treatment planning and load control are applied.

Keywords: Dental Implants, Extra-Short Implants, Narrow-Diameter Implants, Crown-to-Implant Ratio (CIR), Marginal Bone Loss, Implant Survival.

INTRODUCTION

The relationship between implant length and the height of the prosthetic restoration has traditionally been considered a critical factor in the biomechanical stability of implant-supported rehabilitations [1–5]. In particular, the crown-to-implant ratio (CIR) has been the subject of debate for decades, as it has been assumed that high values could increase stress at the bone–implant interface and compromise long-term survival [2,5–8]. This concept, largely inherited from tooth-supported prosthodontics, has been progressively questioned as clinical evidence has demonstrated a more complex behavior in the dental implant environment [5]. A major difference between teeth and implants is that the latter lack a periodontal ligament, which substantially modifies load transmission and the biomechanical response of the system [9,10]. In this regard, experimental analyses and finite element models have shown that an increase in the crown-to-implant ratio increases the bending moment, but this does not necessarily translate into a clinically significant increase in marginal bone loss when other factors such as prosthetic design, load distribution, or bone quality are adequately controlled [11–17].

In recent years, the interest in short and ultra-short implants has revived the debate regarding the clinical relevance of the CIR. In these situations, high ratios are frequently found, sometimes exceeding 2 or even 3, particularly in posterior regions with advanced bone atrophy. Despite this, multiple clinical studies have reported high survival rates in short implants with crown-to-implant ratios greater than 2, without a significant increase in biological complications [2,4,7,8,18]. In a retrospective study with up to 10 years of follow-up, Luca Malchiodi *et al.,*[19] did not find a significant association between CIR and implant failure rate, even in ultra-short implants, suggesting that this parameter may have a limited clinical impact under certain conditions. In parallel, the use of narrow-diameter implants has expanded indications in cases of horizontal atrophy, avoiding bone augmentation procedures. However, the combination of ultra-short and narrow implants creates a particularly demanding biomechanical scenario, in which the crown-to-implant ratio may reach high values and where evidence in the international literature remains limited [7,8].

From a clinical perspective, the relevance of CIR must be interpreted within a multifactorial system in which variables such as bone quality, primary stability, implant–abutment connection type, prosthetic design, and control of occlusal loads are involved. In this sense, more recent literature suggests that the influence of CIR on marginal bone loss may be lower than traditionally assumed, especially in the presence of progressive loading protocols and optimized prosthetic designs [2,4,6–8,14–18]. Despite the growing body of evidence, available data on extremely high crown-to-implant ratios (≥3), particularly in ultra-short and narrow-diameter implants, remain limited. Therefore, the aim of the present study is to retrospectively analyze the clinical performance of extra-short implants (4.5–6.5 mm) and narrow diameter (3–3.5 mm) in situations with crown-to-implant ratios ≥3, evaluating their survival and bone stability in the medium term.

MATERIALS AND METHODS

Clinical records of patients who received implants with lengths between 4.5 and 6.5 mm, supporting single restorations and with diameters between 3 and 3.5 mm, placed in 2020, were retrospectively reviewed so that the study group would have a minimum of five years of loading. Before implant insertion, antibiotic premedication was administered consisting of 2 g of amoxicillin orally one hour before the intervention and 1 g of paracetamol orally (as analgesic). Each case was evaluated using a diagnostic wax-up and a three-dimensional study of the bone bed using cone beam computed tomography (CBCT), complemented with digital planning software (BTI-Scan III). This information allowed individualized adaptation of the drilling sequence [20], optimizing primary stability without generating excessive bone compression and ensuring a conservative surgical protocol respectful of peri-implant bone tissue. Preoperatively, antibiotic prophylaxis with 2 g of amoxicillin orally one hour before the intervention was administered, along with 1 g of paracetamol as analgesic. The antibiotic regimen continued after surgery with amoxicillin (500–750 mg every 8 hours, adjusted to body weight) for five days. All procedures were performed under local anesthesia, using nerve block or infiltration. Implant insertion was carried out by the same surgeon using a biological drilling technique at low speed without irrigation [21]. Once the definitive crown was placed, the patient attended follow-up visits at one month, three months, and subsequently every six months. During these visits, periapical radiographs were taken and clinical evolution was assessed.

Periapical radiographs were taken using positioning devices to ensure reproducible images, while panoramic radiographs were obtained using a standardized positioning protocol: fixed support of glabella and chin, bite block in the interincisal area, alignment with the bipupillary plane and Frankfurt plane guided by laser, and foot positioning on floor markers. All images were obtained in digital format and calibrated using ImageJ software (NIH, Bethesda, MD, USA), using the real implant length as a reference to correct magnification and allow precise linear measurements. Measurements focused on evaluating crestal bone loss, calculated by measuring from the implant shoulder to the first point where bone–implant contact was evident. The reference for comparing radiographic records and thus estimating bone loss in each patient was the radiograph taken at the time of loading.

Statistical Analysis

A Shapiro–Wilk test was performed on the data obtained to verify normal distribution of the sample. The main variable evaluated was implant survival, followed by crestal bone loss. Survival analysis was carried out using the Kaplan–Meier method, and statistical processing was performed with SPSS v15.0 software (SPSS Inc., Chicago, IL, USA). Qualitative variables were described through frequency analysis. Quantitative variables were described using mean and standard deviation.

RESULTS

Six patients were included in whom 24 implants meeting the inclusion criteria were placed. The mean age of the patients was 68.82 years (± 4.70), with 4 of the 6 being women. Regarding implant position, 16.7% of implants were placed in positions 35 and 36. The remaining positions are shown in Figure 1.

Implant diameters ranged between 3 and 3.5 mm, with 3.5 mm being the most frequent. Implant lengths ranged between 4.5 and 6.5 mm, with 5.5 mm being the most common. All diameters and lengths are shown in Figure 2. The mean bone density of implant insertion sites was 791.66 (± 292.91), and the mean

insertion torque was 38.54 Ncm (± 18.62). The mean bone height at implant placement sites was 8.56 mm (± 2.86).

During implant placement, 8 implants were placed with adjunctive techniques, with overcorrection being the most frequent in 7 of the 8 implants and vertical augmentation in the remaining one. In all cases, PRGF-Endoret combined with autologous bone obtained from drilling was used as graft material. In 4 of the 6 patients, full-arch prostheses were fabricated, while the remaining two received fixed bridges. The mean prosthesis length was 18.93 mm (± 2.10), with a mean ratio of 3.27 (± 0.26), ranging between 3 and 3.9. When analyzing data according to implant length, the following results were observed: 4.5 mm implants: mean CIR of 3.35 ± 0.21 (n = 2); 5.5 mm implants: mean CIR of 3.33 ± 0.30 (n = 13); 6.5 mm implants: mean CIR of 3.15 ± 0.17 (n = 9) (Figure 3).

Immediate loading was performed in 20 implants, while a delayed loading protocol was used in the remaining 4. In both immediate and delayed loading cases, a provisional screw-retained prosthesis on transepithelial abutments with a bar structure covered in resin was fabricated. Definitive prostheses were made in metal–ceramic, also screw-retained on transepithelial abutments.

The mean follow-up time was 62.6 ± 7.8 months. During this period, no implant failures were recorded, resulting in a 100% survival rate. Regarding prostheses, a total of 7 adverse events were documented, 6 corresponding to screw loosening episodes and 1 to a minor ceramic fracture. All events were resolved satisfactorily without compromising restoration function, resulting in a 100% prosthetic survival rate. Mean crestal bone loss at the end of follow-up was 0.42 mm (± 0.59) mesially and 0.45 mm (± 0.70) distally. Figures 4–14 show one of the cases included in the study.

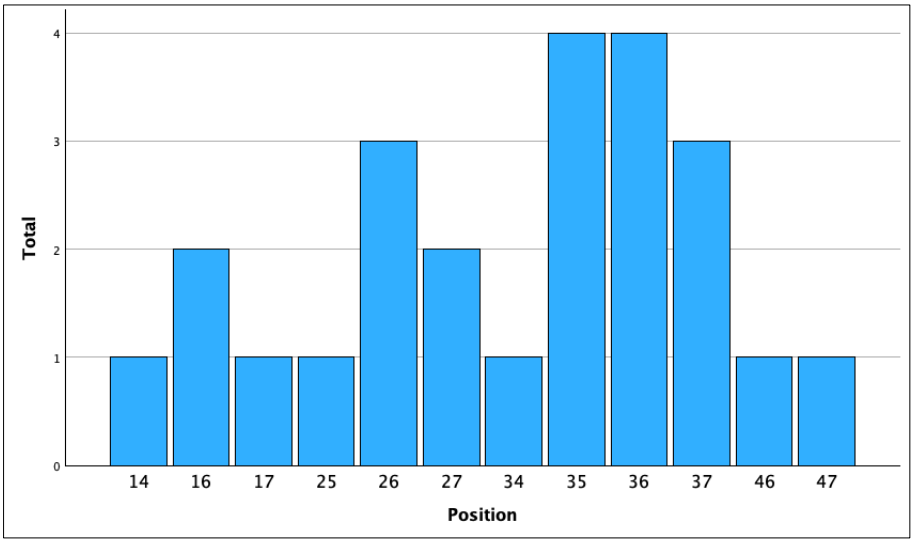


Figure 1: Positions of the implants included in the study

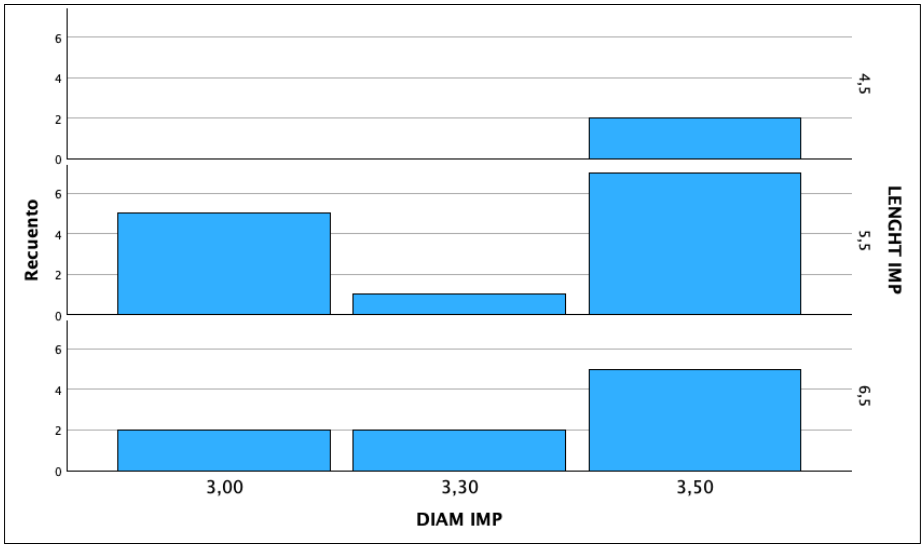


Figure 2: Diameters and lengths of the implants included in the study

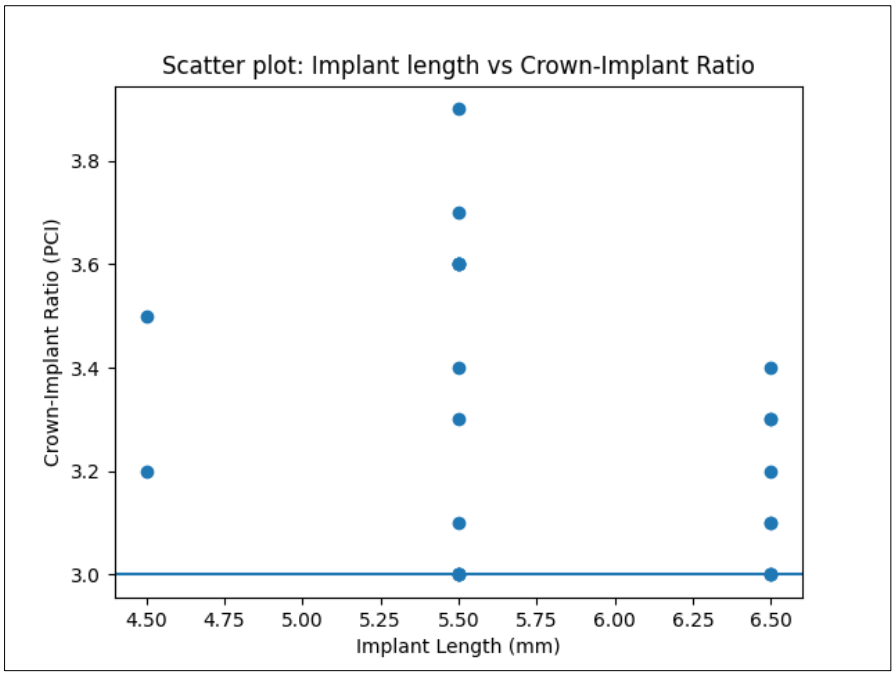
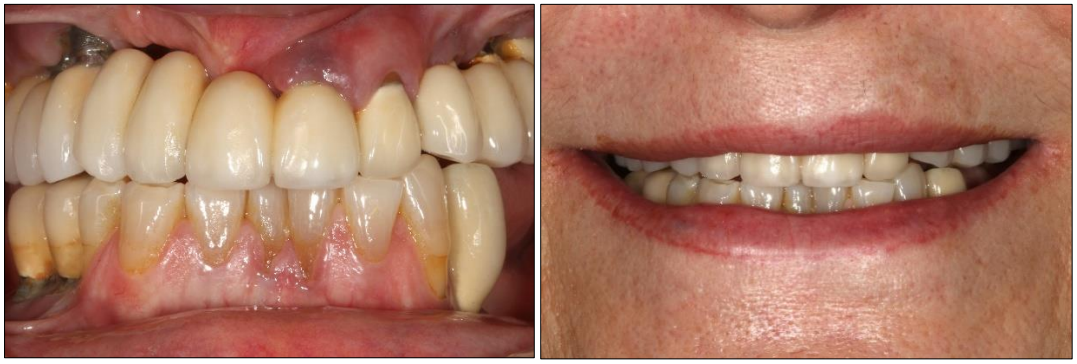


Figure 3: Crown-to-implant ratio according to implant length



Figures 4 and 5: Initial images of the patient showing advanced peri-implantitis in the upper arch

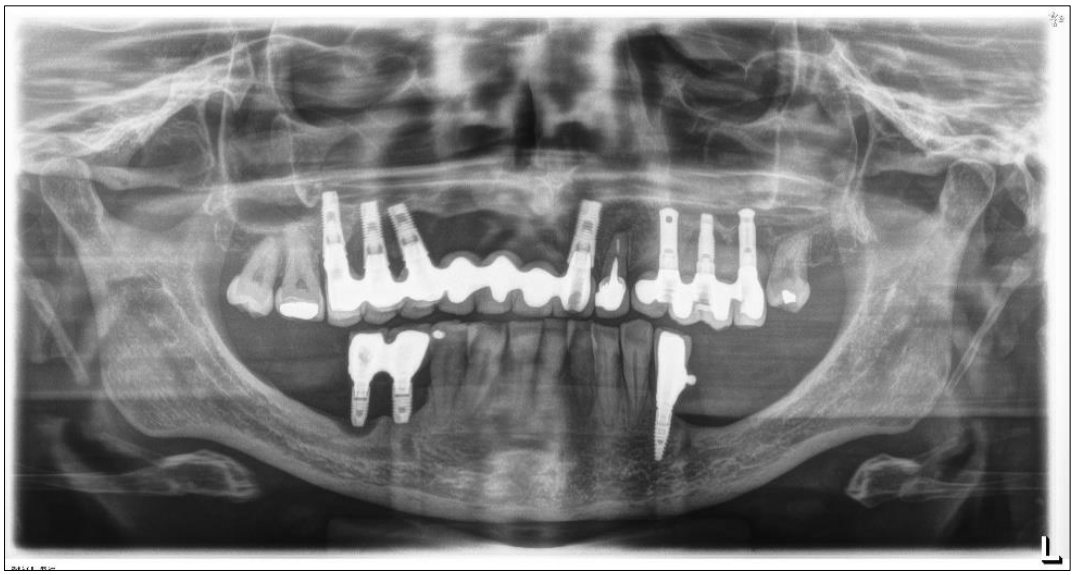
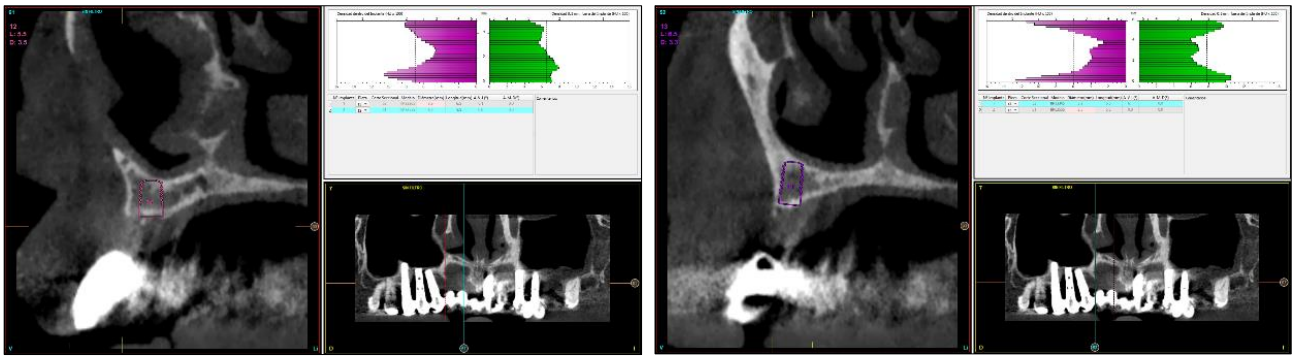


Figure 6: The radiograph confirms this, as well as the poor condition of the implants in the fourth quadrant, which must also be explanted. Sinusitis in the second quadrant can also be observed



Figures 7 and 8: Cone-beam sectional views showing the bone defect in the first quadrant and the severe horizontal and vertical atrophy present in the area, as well as the implants planned for insertion, which are short and narrow

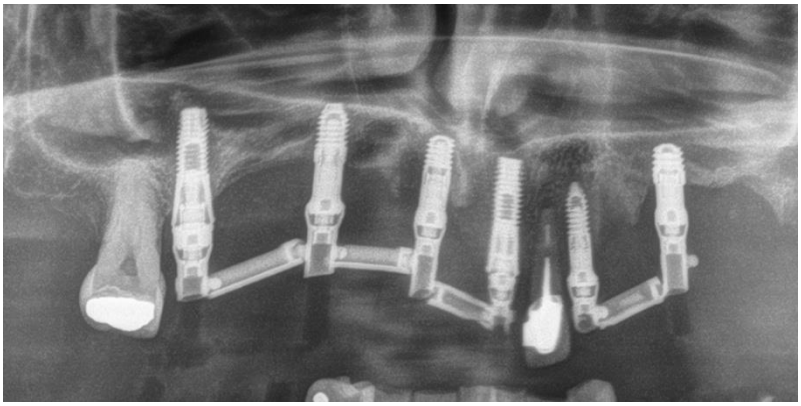


Figure 9: First phase of provisionalization with the implants inserted and some remaining implants preserved from the patient's previous rehabilitation. As observed, an immediate screw-retained loading was performed on transepithelial abutments with an articulated bar structure

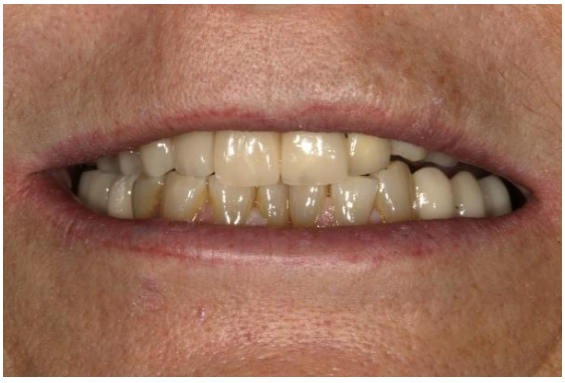
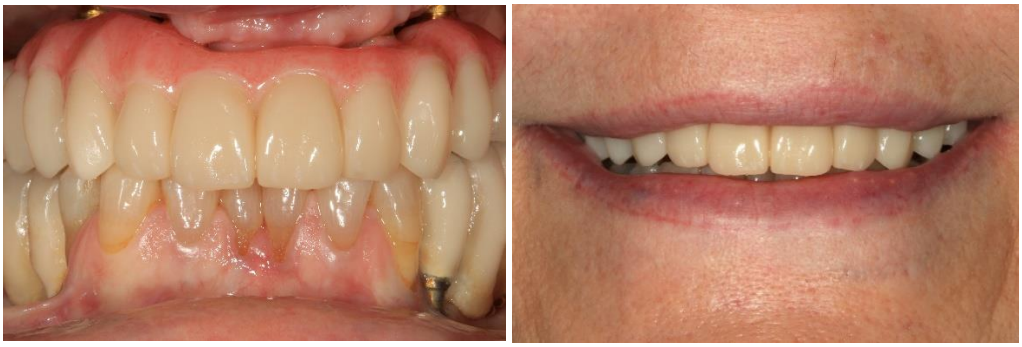


Figure 10: Clinical image of the immediate loading



Figures 11 and 12: Definitive prosthesis newly placed

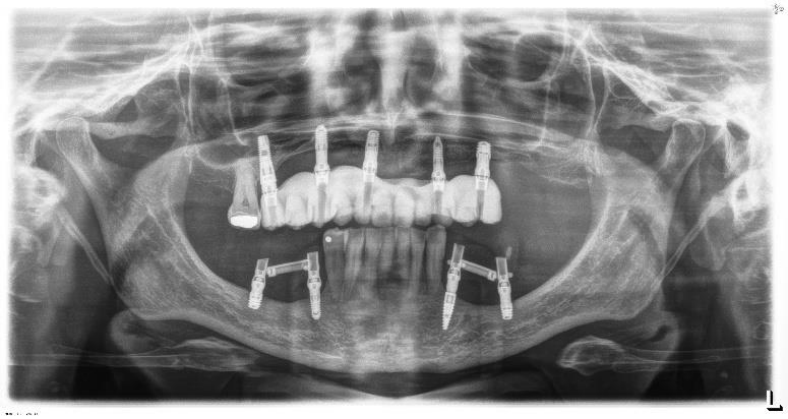


Figure 13: Radiograph of the placement of the definitive prosthesis, where the crown-to-implant ratio of the short implants located anteriorly in the first quadrant is evident, with a ratio greater than 3

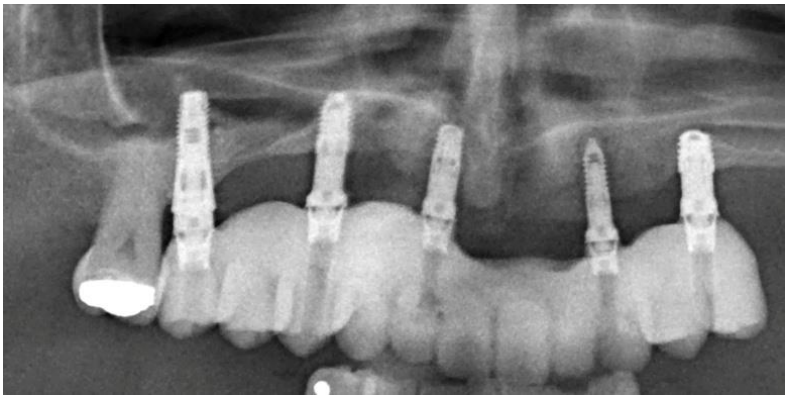


Figure 14: Radiographic image at 5-year follow-up, where the severe bone atrophy can be observed in greater detail, which has been resolved with short and narrow implants, as well as their stability over time despite the the high crown-to-implant ratio

DISCUSSION

The results of the present study show that the use of extra-short, narrow-diameter implants in situations with crown-to-implant ratios ≥3 can achieve favorable clinical outcomes in the medium term, both in terms of survival and bone stability. The absence of failures after a follow-up period of more than five years and the limited values of crestal bone loss suggest that, even under theoretically unfavorable biomechanical conditions, clinical behavior can be predictable when factors related to planning and functional loading are adequately controlled [12,14,16].

One of the most relevant findings is the stability of the crestal bone observed in the series, with mean bone loss values below 0.5 mm after more than five years in function. These results are comparable, and even lower, than those described in the literature for short and ultra-short implants. In a multicentre randomized study, Zadeh *et al.,*[22] reported a mean marginal bone loss of 0.57 ± 0.83 mm at 3 years in short and conventional implants, without significant differences between groups. Similarly, Rossi *et al.,* [23,24] observed bone losses of 0.2 ± 0.4 mm in short implants after follow-ups of 5 to 10 years, even in situations with high crown-to-implant ratios. These data reinforce the idea that the magnitude of CIR does not, by itself, constitute a direct determinant of peri-implant bone remodelling.

A particularly relevant aspect is the analysis of CIR at extreme values (≥3), which remains scarcely represented in the literature. Most available studies analyze ratios between 1 and 2.5, with limited data on values greater than 3. In this regard, Malchiodi *et al.,*[19], in a retrospective study with follow-up of up to 10 years, did not find a significant association between CIR and implant failure [13,14,16] nor with marginal bone loss, even in ultra-short implants. The authors reported survival rates above 95% and mean bone losses below 1 mm, regardless of the crown-to-implant ratio. These data are consistent with the findings of the present study and reinforce the hypothesis that CIR should be interpreted within a multifactorial system.

From a biomechanical perspective, the increase in bending moment associated with high ratios does not necessarily translate into clinical deterioration when strategies that promote load distribution are used [3,14,16]. In this series, the systematic use of screw-retained prostheses on transepithelial abutments and progressive loading protocols may have contributed to mitigating the lever effect generated by high crowns [25]. Experimental studies have shown that load

distribution can be significantly modified by prosthetic design, reducing stress concentration at the crestal bone even in the presence of unfavorable relationships between prosthetic height and implant length [25–27].

The incidence of prosthetic complications observed in the study, mainly screw loosening, is consistent with what has been reported in the literature for restorations with a greater lever arm. Systematic reviews have indicated that technical complications, especially screw loosening, can reach rates of 10–20% in follow-ups longer than 5 years in implant-supported rehabilitations, without necessarily implying treatment failure [28–35]. In this regard, the simple resolution of the observed events and the absence of relevant biological complications reinforce the clinical viability of the approach used.

Another aspect to consider is the role of reduced diameter in this type of rehabilitation. Although a higher biomechanical risk could theoretically be expected, clinical studies have shown that implants with diameters ≤3.5 mm can achieve survival rates above 95% in posterior regions, even under demanding functional loading conditions. Pommer *et al.,*[36], in a meta-analysis, reported survival rates of 96.7% for narrow implants, while Maló *et al.,*[37] described values of 94–96% in rehabilitations of atrophic arches. These data suggest that diameter, like length, does not act in isolation but rather in interaction with other factors within the system.

CONCLUSIONS

The limitations of the present study include its retrospective design, the small sample size, and the absence of a control group. Likewise, two-dimensional radiographic analysis may underestimate bone changes in certain situations. However, the prolonged follow-up and the homogeneity of the clinical protocol provide consistency to the results.

Overall, the findings obtained suggest that the presence of crown-to-implant ratios ≥3 in extra-short, narrow-diameter implants does not necessarily imply worse clinical performance in the medium term. The observed stability appears to depend more on the correct integration of biomechanical and biological factors than on the isolated magnitude of the ratio, which raises the need to reconsider the role of this parameter in clinical decision-making.

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

REFERENCE

1. Lin GH, Lee E, Barootchi S, Rosen PS, Curtis D, Kan J, *et al.,* The influence of prosthetic designs on peri-implant bone loss: An AO/AAP systematic review and meta-analysis. J Periodontol. 2025;96: 634–651. doi:10.1002/JPER.24-0144
2. Di Fiore A, Vigolo P, Sivolella S, Cavallin F, Katsoulis J, Monaco C, *et al.,* Influence of Crown-to-Implant Ratio on Long-Term Marginal Bone Loss Around Short Implants. Int J Oral Maxillofac Implants. 2019;34: 992–998. doi:10.11607/JOMI.7161
3. Manea A, Bran S, Dinu C, Rotaru H, Barbur I, Crisan B, *et al.,* Principles of biomechanics in oral implantology. Med Pharm Rep. 2019;92: S14–S19. doi:10.15386/mpr-1512
4. Garaicoa-Pazmiño C, Suárez-López del Amo F, Monje A, Catena A, Ortega-Oller I, Galindo-Moreno P, *et al.,* Influence of Crown/Implant Ratio on Marginal Bone Loss: A Systematic Review. J Periodontol. 2014;85: 1214–1221. doi:10.1902/jop.2014.130615
5. Tiwari A, Tomer L, Kumari B, Gupta A, Raj K, Prasad S. Comparison between Crown-to-Root Ratio and Crown-to-Implant Ratio in Natural Teeth. J Pharm Bioallied Sci. 2025;17: S1550–S1552. doi: 10.4103/jpbs.jpbs_109_25
6. Blanes RJ, Bernard JP, Blanes ZM, Belser UC. A 10-year prospective study of ITI dental implants placed in the posterior region. II: Influence of the crown-to-implant ratio and different prosthetic treatment modalities on crestal bone loss. Clin Oral Implants Res. 2007;18: 707–714. doi:10.1111/j.1600-0501.2006. 01307.x
7. Malchiodi L, Giacomazzi E, Cucchi A, Ricciotti G, Caricasulo R, Bertossi D, *et al.,* Relationship between crestal bone levels and crown-to-implant ratio of ultra-short implants with a microrough surface: A prospective study with 48 months of follow-up. Journal of Oral Implantology. 2019;45: 18–28. doi:10.1563/aaid-joi-D-17-00204
8. R I, J S, P.S M, N. AL Qahtani F, N KA, M M. A randomized control trial comparing the crestal bone loss between short, wide diameter implants, long and narrow diameter implants with different crown: Implant ratio - A preliminary report. Bioinformation. 2025;21: 3206–3210. doi:10.6026/973206300213206
9. Brunski JB. In vivo bone response to biomechanical loading. Adv Dent Res. 1999;13: 99–119.
10. Ishigaki S, Nakano T, Yamada S, Nakamura T, Takashima F. Biomechanical stress in bone surrounding an implant under simulated chewing. Clin Oral Implants Res. 2003;14: 97–102. doi:10.1034/j.1600-0501.2003. 140113.x
11. dos Santos Marsico V, Lehmann RB, de Assis Claro CA, Amaral M, Vitti RP, Neves ACC, *et al.,* Three-dimensional finite element analysis of occlusal splint and implant connection on stress distribution in implant–supported fixed dental prosthesis and peri-implantal bone. Materials Science and Engineering C. 2017;80: 141–148. doi: 10.1016/J.MSEC.2017.05.071

12. Okada S, Koretake K, Miyamoto Y, Oue H, Akagawa Y. Increased Crown-To-Implant Ratio May Not Be a Risk Factor for Dental Implant Failure under Appropriate Plaque Control. PLoS One. 2013;8: e63992. doi: 10.1371/JOURNAL.PONE.0063992
13. Yuan X, Liu Y, Yang Y, Ren M, Luo L, Zheng L, *et al.,* Effect of short implant crown-to-implant ratio on stress distribution in anisotropic bone with different osseointegration rates. BMC Oral Health. 2023;23: 683. doi:10.1186/S12903-023-03379-Z
14. Bulaqi HA, Mousavi Mashhadi M, Safari H, Samandari MM, Geramipanah F. Effect of increased crown height on stress distribution in short dental implant components and their surrounding bone: A finite element analysis. Journal of Prosthetic Dentistry. 2015;113: 548–557. doi: 10.1016/j.prosdent.2014.11.007
15. Nissan J, Ghelfan O, Gross O, Priel I, Gross M, Chaushu G. The effect of crown/implant ratio and crown height space on stress distribution in unsplinted implant supporting restorations. Journal of Oral and Maxillofacial Surgery. 2011;69: 1934–1939. doi: 10.1016/j.joms.2011.01.036
16. da Rocha Ferreira JJ, Machado LFM, Oliveira JM, Ramos JCT. Effect of crown-to-implant ratio and crown height space on marginal bone stress: a finite element analysis. Int J Implant Dent. 2021;7: 81. doi:10.1186/s40729-021-00368-1
17. Jain R, Pisulkar SG, Dubey SA, Bansod A, Beri A, Deshmukh S. Influence of Crown Height and Width on Marginal Bone Loss and Long-Term Stability of Dental Implants: A Systematic Review. Cureus. 2024;16: e65109. doi:10.7759/cureus.65109
18. Anitua E, Alkhraist M, Piñas L, Begoña L, Orive G. Implant Survival and Crestal Bone Loss Around Extra-Short Implants Supporting a Fixed Denture: The Effect of Crown Height Space, Crown-to-Implant Ratio, and Offset Placement of the Prosthesis. Int J Oral Maxillofac Implants. 2014;29: 682–689. doi:10.11607/jomi.3404
19. Malchiodi L, Ricciardi G, Salandini A, Caricasulo R, Cucchi A, Ghensi P. Influence of crown–implant ratio on implant success rate of ultra-short dental implants: results of a 8- to 10-year retrospective study. Clin Oral Investig. 2020;24: 3213–3222. doi:10.1007/s00784-020-03195-7
20. Anitua E, Alkhraisat MH, Piñas L, Orive G. Efficacy of biologically guided implant site preparation to obtain adequate primary implant stability. Annals of Anatomy. 2015;199: 9–15. doi: 10.1016/j.aanat.2014.02.005
21. Anitua E, Carda C, Andia I. A novel drilling procedure and subsequent bone autograft preparation: a technical note. Int J Oral Maxillofac Implants. 22: 138–45. Available: http://www.ncbi.nlm.nih.gov/pubmed/17340908
22. Zadeh HH, Guljé F, Palmer PJ, Abrahamsson I, Chen S, Mahallati R, *et al.,* Marginal bone level and survival of short and standard-length implants after 3 years: An Open Multi-Center Randomized Controlled Clinical Trial. Clin Oral Implants Res. 2018;29: 894–906. doi:10.1111/clr.13341
23. Rossi F, Lang NP, Ricci E, Ferraioli L, Marchetti C, Botticelli D. 6-mm-long implants loaded with fiber-reinforced composite resin-bonded fixed prostheses (FRCRBFDPs). A 5-year prospective study. Clin Oral Implants Res. 2017;28: 1478–1483. doi:10.1111/CLR.13015
24. Rossi F, Tuci L, Ferraioli L, Ricci E, Suerica A, Botticelli D, *et al.,* Two-year follow-up of 4-mm-long implants used as distal support of full-arch fdps compared to 10-mm implants installed after sinus floor elevation. A randomized clinical trial. Int J Environ Res Public Health. 2021;18. doi:10.3390/ijerph18073846
25. Anitua E, Piñas L, Alkhraisat MH. Implant-supported prosthesis under progressive loading protocol stimulates alveolar bone growth in patients with severe alveolar bone atrophy. Retrospective case series. Frontiers in dental medicine. 2024;5: 1465137. doi:10.3389/fdmed.2024.1465137
26. Misch CE. Progressive loading of bone with implant prostheses. J Dent Symp. 1993;1: 50–53.
27. Sanz-Sánchez I, Sanz-Martín I, Figuero E, Sanz M. Clinical efficacy of immediate implant loading protocols compared to conventional loading depending on the type of the restoration: A systematic review. Clin Oral Implants Res. 2015;26: 964–982. doi:10.1111/clr.12428
28. Papaspyridakos P, De Souza A, Vazouras K, Gholami H, Pagni S, Weber HP. Survival rates of short dental implants (≤6 mm) compared with implants longer than 6 mm in posterior jaw areas: A meta-analysis. Clin Oral Implants Res. 2018;29 Suppl 16: 8–20. doi:10.1111/CLR.13289
29. Papaspyridakos P, Chen C-J, Chuang S-K, Weber H-P, Gallucci GO. A systematic review of biologic and technical complications with fixed implant rehabilitations for edentulous patients. Int J Oral Maxillofac Implants. 27: 102–10. Available: http://www.ncbi.nlm.nih.gov/pubmed/22299086
30. Anitua E, Flores C, Piñas L, Alkhraisat MH. Frequency of technical complications in fixed implant prosthesis: The effect of prosthesis screw emergence correction by computer-aided design/computer-aided manufacturing. Journal of Oral Implantology. 2018;44: 427–431. doi:10.1563/AAID-JOI-D-17-00229
31. Yi Y, Heo SJ, Koak JY, Kim SK. Mechanical complications of implant-supported restorations with internal conical connection implants: A 14-year retrospective study. Journal of Prosthetic Dentistry. 2023;129: 732–740. doi: 10.1016/j.prosdent.2021.06.053
32. Goodacre BJ, Goodacre SE, Goodacre CJ. Prosthetic complications with implant prostheses (2001-2017). Eur J Oral Implantol. 2018;11: s27–s36.

33. Stavropoulos A, Bertl K, Eren S, Gotfredsen K. Mechanical and biological complications after implantoplasty - A systematic review. Clin Oral Implants Res. 2019;30: 833–848. doi:10.1111/clr.13499
34. Rinke S, Roediger M, Eickholz P, Lange K, Ziebolz D. Technical and biological complications of single-molar implant restorations. Clin Oral Implants Res. 2015;26: 1024–1030. doi:10.1111/clr.12382
35. Berglundh T, Persson L, Klinge B. A systematic review of the incidence of biological and technical complications in implant dentistry reported in prospective longitudinal studies of at least 5 years. J Clin Periodontol. 2002;29: 197–212. doi:10.1034/j.1600-051X.29.s3.12.x
36. Pommer B, Mailath-Pokorny G, Haas R, Buseniechner D, Millesi W, Fürhauser R. Extra-short (< 7 mm) and extra-narrow diameter (< 3.5 mm) implants: A meta-analytic literature review. Eur J Oral Implantol. 2018;11: s137–s146.
37. Maló PS, de Araújo Nobre MA, Lopes A V., Ferro AS. Retrospective cohort clinical investigation of a dental implant with a narrow diameter and short length for the partial rehabilitation of extremely atrophic jaws. J Oral Sci. 2017;59: 357–363. doi:10.2334/JOSNUSD.16-0321