Early Soft Tissue Response to Immediate Monotype Zirconia Implant: A Metal-Free Restoration

Riccardo Scaringi[1] Alessio Franchina[2] Luca Fiorillo[3,4,5] Fulvia Galletti[6] Luigi Stefanelli[7] Stefano Di Carlo[8] Francesca De Angelis[9]

[1] Private Practice, Milano, Italy
[2] Private Practice, Periodontal and Dental Implant Surgery, Vicenza, Italy
[3] Department of Biomedical and Dental Sciences and Morphological and Functional Imaging, University of Messina, Messina, Italy
[4] Department of Prosthodontics, Dr. D. Y. Patil Dental College and Hospital, Dr. D. Y. Patil Vidyapeeth, Pune, Maharashtra, India
[5] Multidisciplinary Department of Medical-Surgical and Dental Specialties, Second University of Naples, Naples, Italy
[6] Private Practice, Periodontal and Dental Implant Surgery, Messina, Italy
[7] Private Practice, Periodontal, and Dental Implant Surgery, Roma, Italy
[8] Department of Oral and Maxillo-Facial Sciences, Sapienza University of Rome, Rome, Italy
[9] Department of Oral and Maxillo-Facial Sciences, Sapienza University of Rome, Rome, Italy

Address for correspondence Luca Fiorillo, DDS, Msc, PhD, Department of Biomedical and Dental Sciences and Morphofunctional Imaging, Messina University, Via Consolare Valeria, 1–98100, Messina, Italy (e-mail: lfiorillo@unime.it).

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Abstract

Zirconia in dentistry (zirconium oxide) is an excellent substitute for metal in creating bridges or crowns on both natural teeth and implants and for dental implant fabrication instead of titanium alloys. This case report aims to show the features of zirconia dental implants and prosthodontic restorations to oral soft tissues. Three monotype immediate zirconia implants were placed at the time of tooth extraction. The residual socket gap was treated only by establishing a collagen sponge to stabilize the natural blood clot. Three single zirconia crowns were cemented after 2 months of healing. After 3 years of follow-up, clinical and radiographic stability was demonstrated, confirming the zirconia implants' excellent soft tissue and osseointegration. A zirconia cutback was planned to improve the esthetic result of the whole crown. After 3 years of follow-up visits, clinical and radiographic stability confirmed the optima soft tissue and osseointegration outcome of zirconia implants. Zirconia implants are a valid alternative to titanium implants for treating partial edentulism.

Keywords
- zirconia
- monotype zirconia implants
- soft tissue
- cut-back
- metal-free restoration

Introduction

The osseointegration process has been widely proven in the literature, although many implant macro- and micro-topographies were reported.[1]

Wilson and Weber, in 1993, proposed the first timeline classification for implant placement, splitting them into immediate, recent, delayed and mature placements, depending on the time between extraction and implant achievement.[2]

Hämmerle et al revised this classification as the previous classification, dividing immediate implants into four types of scenarios and defining the advantages and disadvantages of performing the implant at the time corresponding to the respective type.[3]

Many authors considered the alveolar topography, the extraction less-invasivity, and the implant primary stability the main factors to achieve success.[4]

Despite the surgical technique proposed for immediate implants undergoing improvements and success rates comparable to those reported for delayed and mature implant placements, mucositis and peri-implantitis due to metal and/or manufacturing remnants were said to be relevant.[5–7]

Considering the positive soft tissue responses assessed when ceramic restorations were used, industry and

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research focused on developing new materials to address this issue.[8]

Compared with ceramics for dental prostheses, the increased mechanical properties of zirconia frameworks allowed the development of this material for dental implant manufacturing, ideally chosen to treat the esthetic areas or patients with many general allergies.[9]

Zirconia has an elastic modulus and tensile stress similar to or superior to titanium as long as the structure's thickness is maintained.[10]

Superficial in vivo and in vitro studies have shown that physicochemical properties inhibit bacterial adherence to zirconia in the oral cavity.[11,12]

The macrogeometry of these devices, as for titanium implants, is provided with two different possibilities: monophasic, that is, a single piece joining together the fixture and the abutment and biphasic, where an abutment–fixture connection physically exists. Monophasic implants have more excellent resistance to mechanical stresses, allowing them to develop smaller implants than standard ones. The variable abutment's heights and different geometries make possible the treatment of different scenarios, even though implant placement should be accurate, to comply with the prosthetic plan and the available room. Typically, the monophasic implant should be placed with the neck out of the bone crest at the soft tissue level.[13]

Biphasic implants offer greater surgical and prosthetic versatility and are often achieved at or above the bone crest. Even though they empower both cemented or screw-retained restorations, a narrower range of prosthetic solutions makes the main difference compared with conventional titanium and monophase implants, which can only allow cemented restoration.[14,15]

This article illustrates a 3-year follow-up clinical case performed with monophase implants to replace three teeth.

Case Report

The clinical case concerns treating a healthy Physical Status Classification System (ASA 1) 48-year-old male patient who needed to replace hopeless teeth 4.4, 4.5, and 4.6 (►**Fig. 1A, B**). An orthopanoramic tomography (►**Fig. 2**) was taken as the primary analysis, followed by a cone-beam computed tomography to carry out a three-dimensional assessment of hard tissues and to set a guided prosthetically-driven implant plan. An intraoral scan was performed using a scanner (Trios, 3 Shape) (►**Fig. 3A, B**) and the resulting scans allowed to make a digital wax-up of the future teeth (►**Fig. 3C, D**). The prosthetic analysis was performed digitally, and it revealed physiologic prosthetic rooms except on tooth 4.4, where the antagonist extrusion reduced the vertical dimension. The guided surgical plan was performed because of the poor versatility of the selected monophase zirconia implant (Monotype, Straumann). The case assessment addressed the possibility of immediate implants with delayed bone healing.

The patient underwent antibiotic prophylaxis with amoxicillin 2000 mg, taken 1 hour before the surgery and 1000 mg of the same medication 6 hours later.

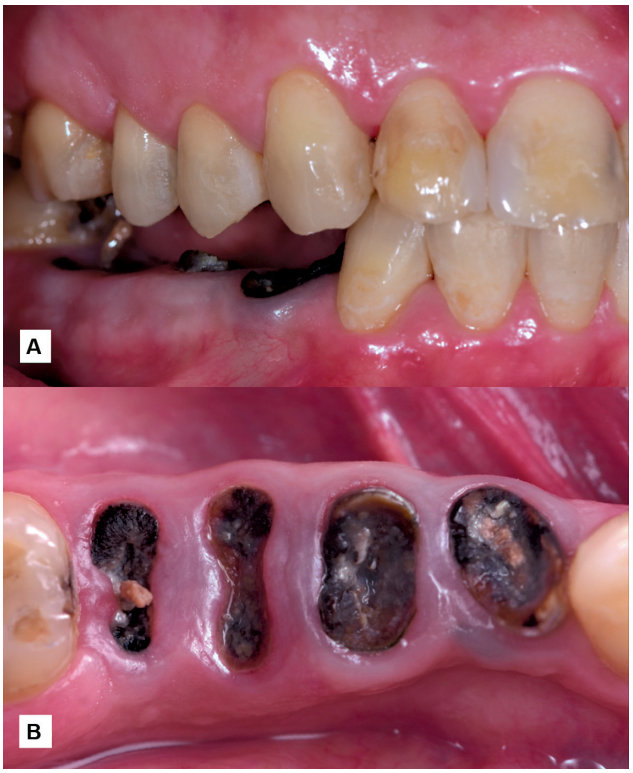

Fig. 1 The clinical dental status of the first and the fourth quadrant showing the hopeless teeth into occlusion (**A**) and form an occlusal view (**B**).

At the time of intervention, gentle extractions were performed under local anesthesia (articaine 40-mg/adrenaline 1:100.000), maintaining both bone and soft tissues intact.[16] Then, a pilot surgical guide was used to prepare implant sites, trying to respect the ideal prosthetic plan and utilizing the extra-socket bone (►**Fig. 4A**). Then, each implant was placed, whose dimension was 4×12mm for the implant body and 5.5 mm at the abutment side for sites 4.6 and 4.5 (►**Fig. 4B**). The reduction in the prosthetic space on 4.4 required using a 4 mm abutment implant. The final implant insertion torque reached was below 30N, and according to the existing literature, delayed prosthetic loading was selected.[17] The residual bone gap between the alveolar buccal wall and the implant was filled with blood clots stabilized with a collagen sponge without any other bone substitute. The surgical procedure ended with applying a poly-ether-ether-keton healing cup over each abutment and some single sutures to stabilize gingival margins (►**Fig. 4C**). A postoperative X-ray was performed (►**Fig. 4D**).

After 10 days of healing, the sutures were removed. The healing time was set in 2 months, and after an X-ray was taken to confirm osteointegration, the prosthetic phase started. In the first appointment, the silicon conventional impression was performed after applying snap-on transfer over each abutment. The different colors of coping codified the different heights of the abutment (►**Fig. 5A, B**). After the technician poured the plaster cast with implant analogues embedded, an extraoral optical scan was performed to start the definitive zirconia crown planning with a digital workflow (►**Fig. 5C, D**). The final crowns, due to the monotype

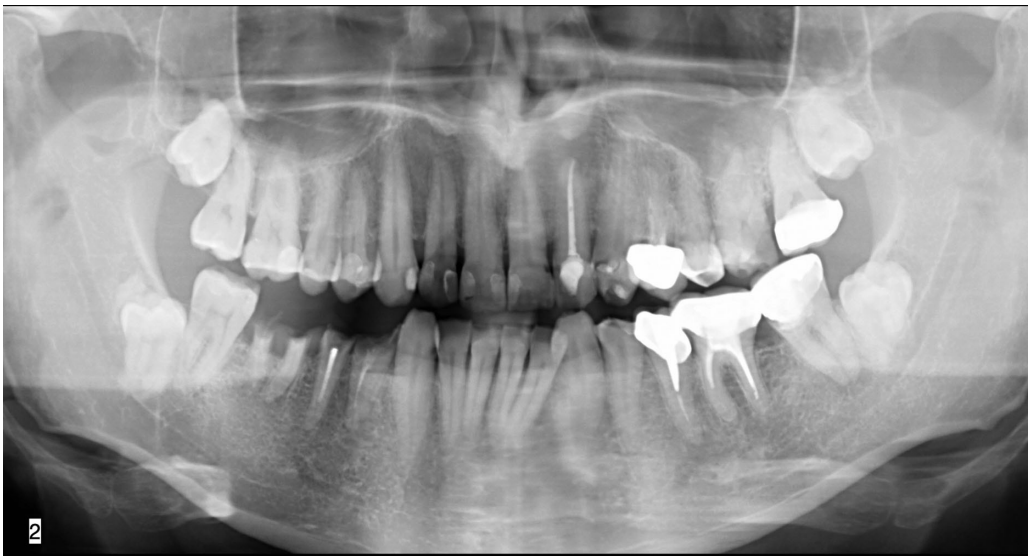

Fig. 2 The orthopanoramic tomography was used for a primary assessment of the oral status revealing the failure of treatments involving teeth 4.4, 4.5, and 4.6.

implant used, were cemented, and their digital design provided a final cut-back of the zirconia core to stratify the final ceramic layer of the crowns to obtain the best esthetic result (►**Fig. 6A, B**). The decision to perform single crowns was set to comply with the patient's request.

At the second and last appointment, the crowns were tried, the occlusion was checked, and finally, they were definitively cemented (►**Fig. 7A, B**) with radiopaque resin cement to be able to verify any submucosal excess, as demonstrated by the final X-ray. The implants integrated well with the surrounding soft tissues, and the bone crest remained stable. The proposed implant clinical case report satisfied the patient's request regarding the reported experience and outcome. Three years after finalization, an examination was performed to assess clinical and radiographic assessment (►**Fig. 7C, D**). The obtained result fulfilled the objective clinical needs, perfectly integrating the prosthetic crowns with soft tissues and bone crest stability.

Discussion

The well-described surgical technique for placing immediate titanium implants has also been applied to achieve zirconia implants, even in the case of monophasic ones.[1] It should be

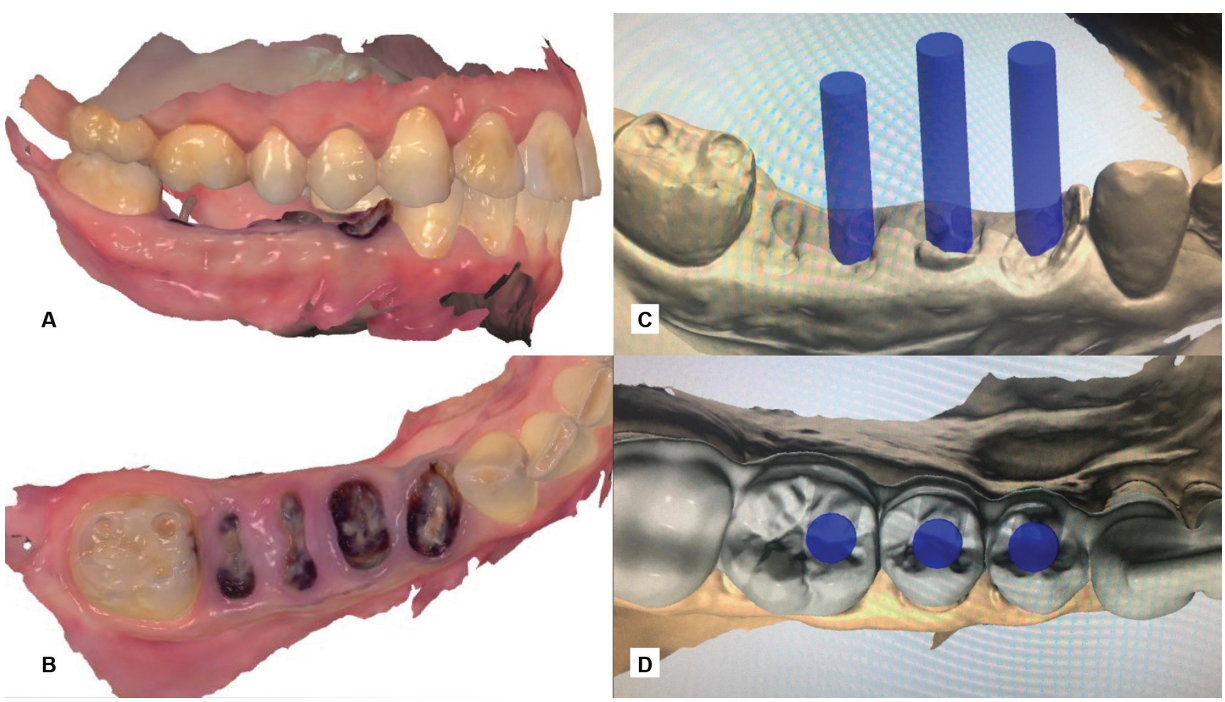

Fig. 3 An intraoral scan was performed (**A, B**) to perform a digital wax-up of future prostheses and plan implant placement (**C, D**) accordingly.

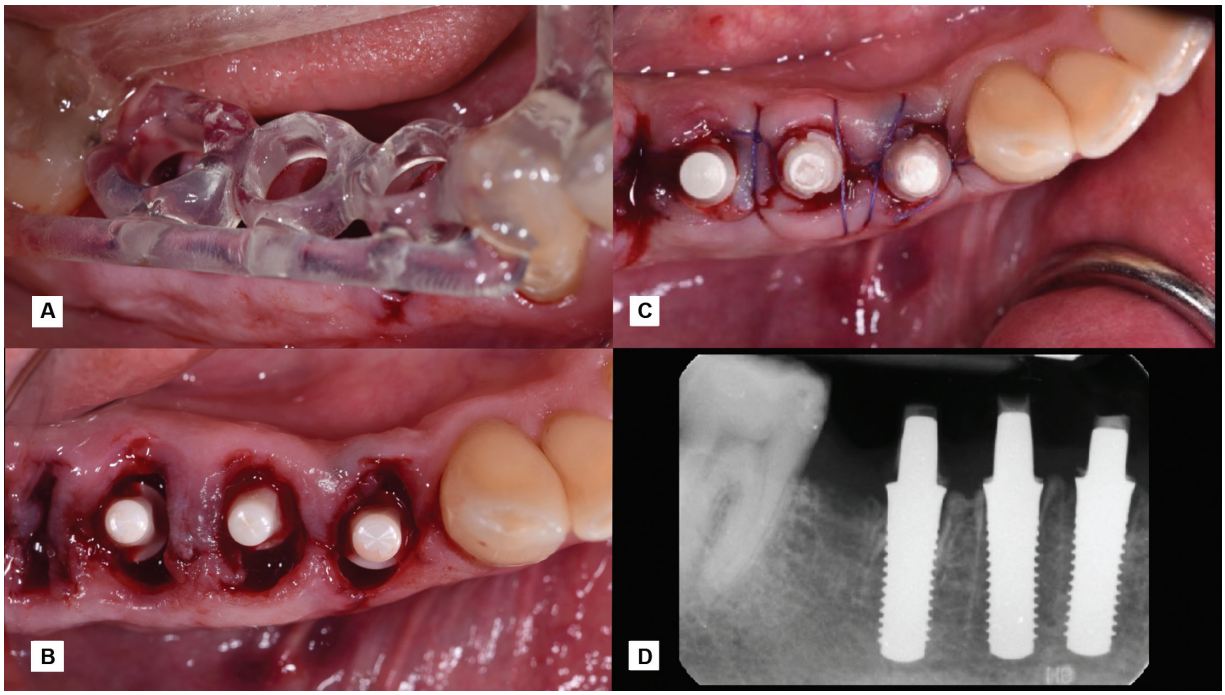

Fig. 4 A pilot surgical stent was printed to guide implant placement (**A**), performed without erasing the flap (**B**). Few sutures were applied to improve soft tissue healing faster (**C**). The intraoral X-ray after 3 months shows the ideal bone healing and osteointegration (**D**).

remarked that the tooth extraction procedure should be performed, leaving the bone crest and the bone septum intact in case of premolar and molar sites to increase the chances of stabilizing the implant with final insertion torque values between 35 and 50N.[16]

Various studies assessed the osseointegration outcome at scanning electron microscopy, showing comparable results to those obtained using titanium implants.[18] As reported by workgroup four at the 2017 world workshop on the classification of periodontal and peri-implant diseases and conditions, a tremendous biological potential is expressed by zirconia's implant higher biocompatibility at the soft tissue level due to the less bacterial adhesion to implant neck surface, resulting in a lower inflammatory risk and consequently less peri-implantitis risk.[6,19] Much research is focused on analyzing soft tissue response, prosthetic

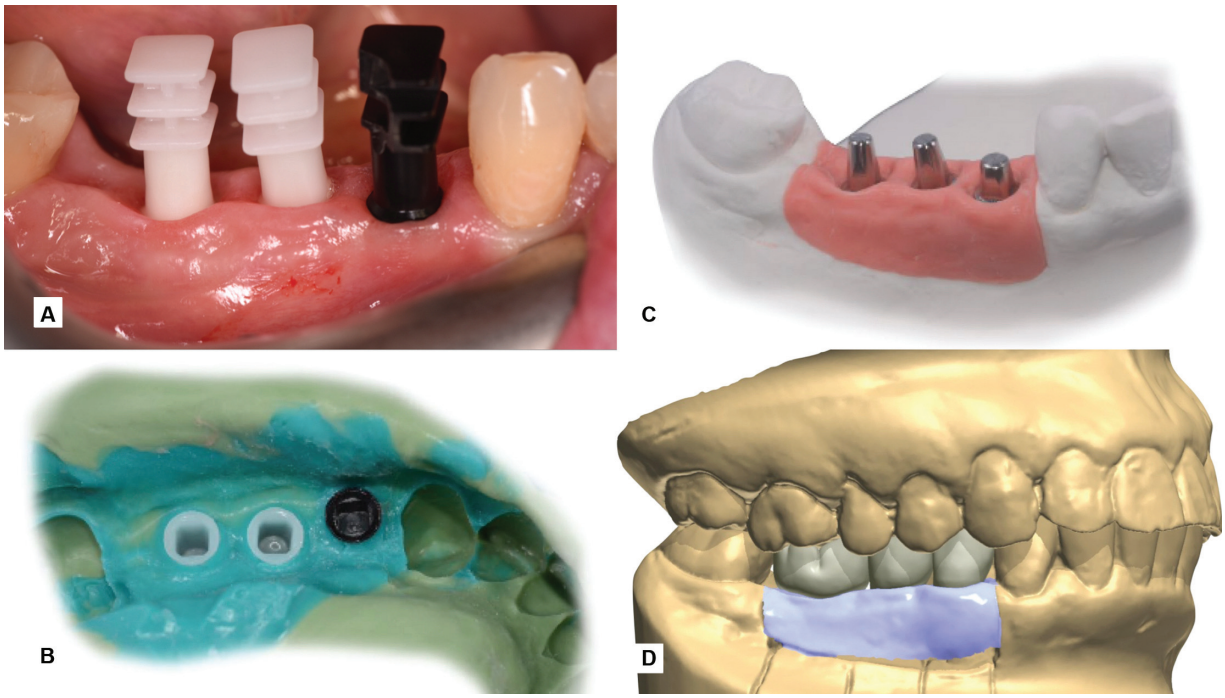

Fig. 5 After 2 months of healing, color-coded snap-on transfers were used to take a conventional impression of the implants (**A, B**). A plaster cast was poured using implant analogues, and definitive crown digital modelling was performed (**C, D**).

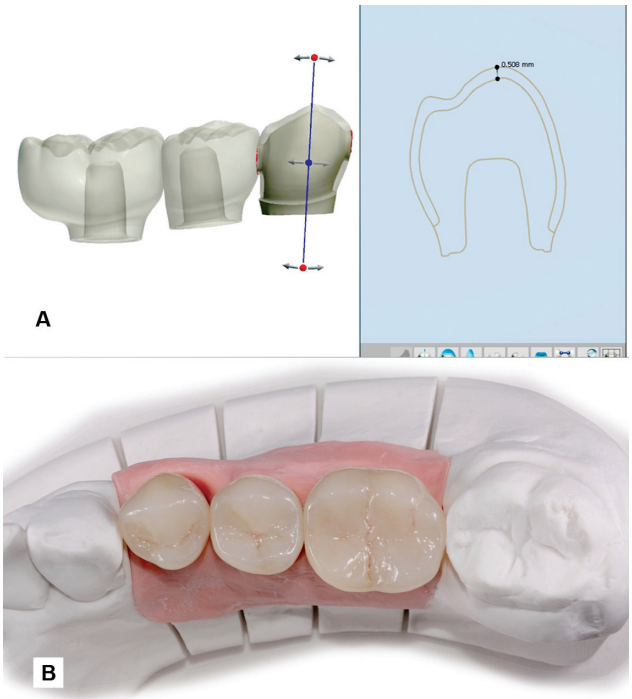

Fig. 6 The computer-aided design project included a 360-degree cut-back of the zirconia framework to stratify a thin ceramic layer (**A, B**).

integration, and comparison between implant materials to determine the most biological one, which can preserve the integrity of the peri-implant soft tissue barrier.[20]

Fretwurst et al, in a recent randomized and controlled clinical trial on advanced peri-implantitis on both titanium and zirconia implants, showed a lack of difference in the clinical behavior, and he stated that beyond the material used for implant fabrication, different peri-implant cellular compositions can be dependent on the patient immunity itself.[21] A limitation of the monotype implant described in this clinical report is the cementation of the overhanging crown: it can represent a risk for biological stability because it incorporates a chance of leaving some cement remnants in the peri-implant sulcus, which can lead the soft tissues to become inflamed and infected. Zirconia implants have also demonstrated positive soft tissue responses due to their lower bacterial adhesion to the implant neck surface, reducing the risk of inflammation and peri-implantitis. However, it is essential to note that the cementation of overhanging crowns on zirconia implants can pose a risk of leaving cement remnants in the peri-implant sulcus, potentially leading to soft tissue inflammation and infection. Using a rubber dam or retractor cords during cementation is recommended to minimize this risk. The case report illustrated zirconia implants' benefits regarding biocompatibility, esthetic outcomes, and biomechanical/occlusal stability.[22–25]

Furthermore, the treatment duration was optimized, and the clinical and esthetic results after 3 years were promising. The patient's expectations regarding requests and results were met, making zirconia implants a viable option for treating partial edentulism. Zirconia implants represent a valid alternative to titanium for treating partial edentulism, offering favorable soft tissue biocompatibility and esthetic results. The reported case demonstrated successful osseointegration and excellent soft tissue integration with zirconia implants. However, caution should be exercised during cementation to minimize the risk of peri-implant complications. Further research and long-term studies are warranted to continue evaluating the performance and biocompatibility of zirconia implants compared with traditional titanium implants in different clinical scenarios.

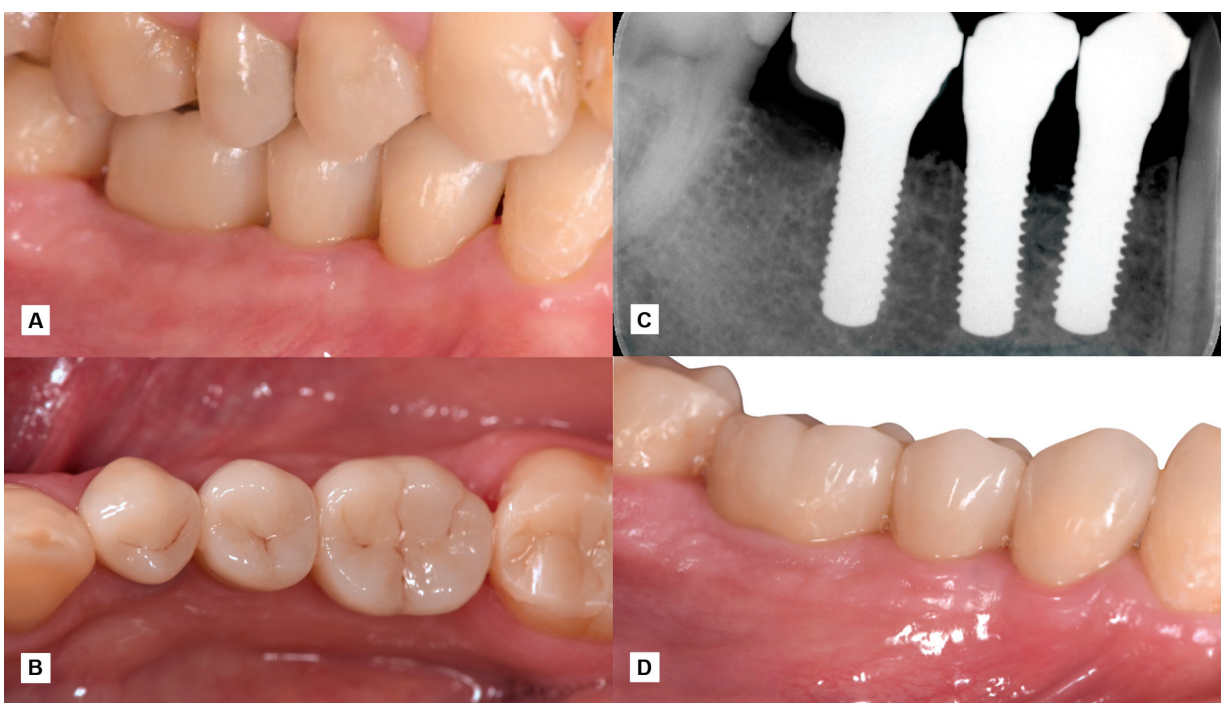

Fig. 7 The definitive single crown restorations were cemented (**A, B**) with radiopaque cement to check for any submucosal excess. A 3-year follow-up visit and X-ray confirmed the perfect integration of the implant-supported crowns (**C, D**) and the soft tissue stability.

Fi-Index Tool

This manuscript has been checked with the Fi-index tool and obtained a score of 0.03 for the complete author list on 04/08/2023, according to SCOPUS.[26,27] The Fi-index tool aims to ensure the quality of the reference list and limit any autocitations.

Conclusions

The reported clinical case shows a modern way to treat partial edentulism with biological and esthetic-oriented treatment. At the same time, the duration of the treatment has been optimized, and the result after 3 years seems promising for both clinical and esthetic response.

Finally, from the patient's view, the result meets its expectations both from the requests and results side.

Authors' Contributions
R.S. and A.F. were involved in conceptualization. R.S. helped in methodology. R.S. and L.S. contributed to resources. L.F. and F.G. helped in data curation. R.S. and F.D.A. were involved in writing—original draft preparation, and S.D.C. and L.F. helped in writing—review and editing; supervision was done by L.F. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
None declared.

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