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Case Report

# Using Distracting Capsule and Resin Bridge for Segmental Distraction Osteogenesis for an Implant-supported Ceramic Crown in the Esthetic Zone of the Anterior Maxilla: 10-year Clinical Report

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## Abstract

Implant therapy for the esthetic zone of the anterior maxilla is a challenge when the support is deficient with the loss of alveolar bone. This article presents a 10-year clinical report of implant therapy for 23-year-old woman with a significant loss of alveolar bone following a loss of the maxillary right central incisor. The central incisor was restored with a screw-retained single implant ceramic crown where the implant site was augmented through sectional distraction osteogenesis involving a distracting capsule and a resin bridge to restore the missing span and serve as an anchorage for distraction. At the 10-year follow-up appointment, the implant-supported crown was stable with no signs or symptoms of biological and/or mechanical complications.

## Introduction

Implant therapy in the esthetic zone of the anterior maxilla is a challenge when the implant site demonstrates a deficiency of alveolar bone [1-7]. When determined a deficiency for an ideal placement of an implant, the implant site is commonly enhanced using grafting or regeneration procedures for horizontal and/or vertical ridge augmentation [1,7]. According to Spray et al,8 the thickness of facial plate can have a significant impact on the success of implant therapy with regard to the stability of marginal bone around the implant.

Distraction osteogenesis is one of the surgical regeneration procedures used to augment implant site [1,6,9-11]. This procedure relies on a biological process of regeneration and consolidation of bone blocks segmented through an osteotomy [9,11]. Once the osteotomy is performed to release a block of bone, the bony segment is slowly distracted in the vertical and horizontal directions to stimulate bone formation according to the morphology of the ridge [11,12]. Compared to a conventional grafting procedure, this procedure is especially advantageous for increasing the height of the ridge keeping with the surrounding soft tissue and blood supply needed to promote the vitality of bone and eliminating the need of harvesting bone transplant [4,9,10,12-18]. According to Chiapasco et al. [1], bone resorption prior to implant placement was less in the distracted site than in the grafted site with autogenous bone.

However, the surgical procedure of distraction requires patient's cooperation, type of distraction device, and minimal height of bone to avoid a fracture [11]. The patient may need more frequent visits during the procedure of the distraction. Other considerations may include relapse or misalignment of the distracted segment, fracture of the distractor, and local infection associated with a long period of retention of distractor needed for stabilizing the distracted segment [6,9,11]. Distractors usually consists of a frame with a spindle that is fixed with plates and screws on the buccal aspect of the bone. Alternatively, distractors are fashioned as a pin-like configuration to perforate the osteotomized segment that is to be distracted [1,9,16].

The purpose of this article was to present a 10-year clinical report of implant therapy for 23-year-old woman with a significant loss of alveolar bone following a loss of the maxillary right central incisor. The central incisor was restored with a screw-retained implant supported ceramic crown, where the implant site was augmented through sectional distraction osteogenesis involving an osseointegrable distracting capsule and a resin bridge fashioned to restore the missing span and serve as an anchorage for distraction. At 10-year follow-up appointment, the implant supported crown was stable with no signs or symptoms of biological and mechanical complications.

## Case Presentation

A 23-year-old woman presented to Implantology Specialty Program at Brazilian Association of Dental Surgeons ABCD-SC in Brazil for restoration of the maxillary right central incisor. A review of the patient's medical history revealed no significant findings. The patient was suffering from an external trauma in the anterior maxilla causing a fracture of the alveolar process supporting the maxillary right central incisor. The central incisor was extracted as a result of the traumatic injury.

Clinical examination revealed that a significant loss of the alveolar bone with a loss of the central incisor (Figure 1). The missing span of the incisor was wider in the mesio-distal dimension than the left central incisor. The gingival mucosa was atrophic and less characterized presenting with a scar tissue on the facial of the injured area. With the deficiency of the alveolar bone, the gingival architecture appeared depressed in the horizontal and vertical directions demonstrating proximal papillae blunted at the coronal aspect. The patient's oral hygiene was favorable with no caries and periodontal breakdown. There were no signs or symptoms of temporomandibular disorder with the mandible demonstrating anterior and lateral guidance in the protrusive and lateral movements. In addition, the patient had no history of smoking and parafunctional oral habits. The tongue function was within normal range.

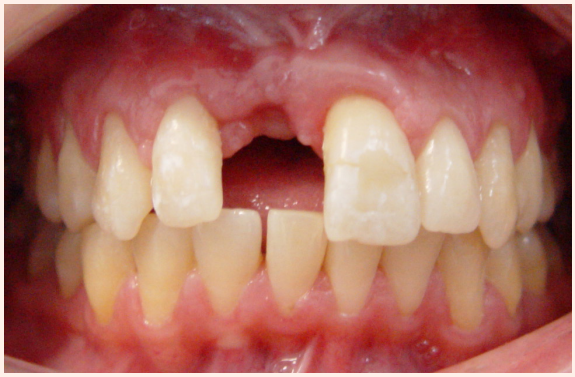

**Figure1:** Frontal view of missing span.

The patient opted for a single implant crown to restore the missing span. The fabrication of a fixed partial denture was ruled out because of the presence of intact adjacent teeth and patient's desire for implant therapy. Diagnostic maxillary and mandibular impressions were made with an irreversible hydrocolloid (Jeltrate, Dentsply Caulk, USA) using stock metal trays. The impressions were poured in ADA Type III dental stone (Microstone, Whip Mix, USA) to produce study casts and mount on a semi-adjustable articulator (Bio-Art, Brazil) to formulate implant therapy. Radiographic evaluation revealed a significant deficiency of the alveolar bone of the missing span for the implant treatment.

The treatment plan included a surgical procedure of sectioning a bony segment to distract and augment the atrophic bone of the anterior maxilla. The patient underwent an implant surgery to place a distracting capsule (3.75 x 7 mm, external hex, S.I.N. implant system, Brazil) in the medial of the alveolar bone (Figure 2). After 4 months of healing for osseointegration of the capsule, an osteotomy for segmental distraction osteogenesis was performed through an incision made in the alveolar crest and detachment of the mucosal flap. The osteotomy was performed using a high-speed bur (H254, Komet, USA) and a chisel (Wedelstaedt #1/2, Hu-Friedy, USA) to section through the buccal cortical bone and separate the medullar and palatal cortical bone from the anterior maxilla (Figure 3). Care was taken to avoid an encroachment against the periodontal membrane of the adjacent teeth and eliminate an interference to the path of distraction of the segmented bone. After verifying the mobility of the bone block, the incision wound was sutured and a resin bridge was cemented (TempBond Clear, Kerr, USA) on the adjacent teeth spanning from the maxillary right canine through left central incisor.

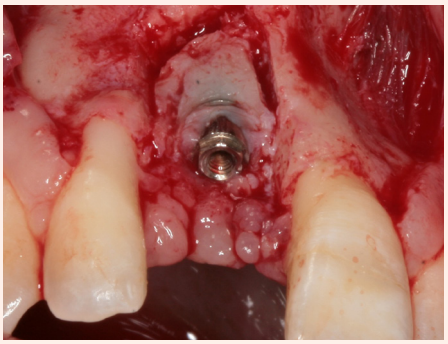

**Figure 2:** Osteotomy performed for segmental distraction osteogenesis. Note the distracting capsule placed in medial of the segmented bone.

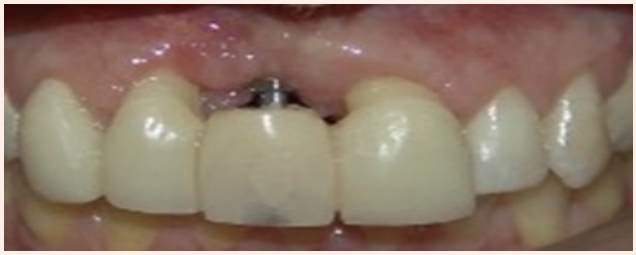

**Figure 3:** Resin bridge engaging the right canine through left central incisor to restore the right central incisor and serve as an anchorage for distraction osteogenesis.

The resin bridge was designed on the mounted study casts according to a diagnostic waxing for replacement of the right central incisor. The bridge was fashioned to demonstrate a pontic to restore the function and esthetics as represented by the right central incisor. A perforation was made using a tungsten carbide bur (E-cutter, Brassler, USA) through the lingual surface of the pontic to permit an insertion of a prosthetic screw (RP 4.1 external hex, S.I.N. implant system, Brazil). The prosthetic screw was screwed into the distracting capsule by engaging the internal threads and mobilizing the entire bone block against the basal bone (Figure 4).

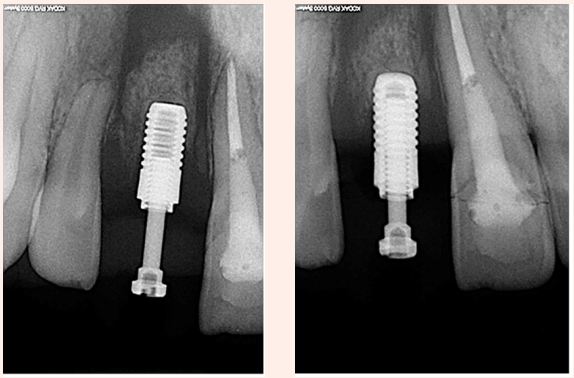

**Figure 4:** Periapical radiographic images showing the mechanism of distraction: (A) initial stage of distraction showing a prosthetic screw engaging a distracting capsule, (B) final stage of distraction showing the prosthetic screw driven toward the apical portion of distracting capsule.

After 1week of latency healing period, the suture was removed and distraction initiated at a rate of approximately 0.7 mm per day (3/4 turn). The activation of the screw was continued for 3 weeks until the distracting capsule was driven to contact against the subsurface of the pontic. During the procedure of distraction, the patient was compliant demonstrating no adverse event with the use of the distraction device. The screw was fixed with an acrylic resin (DuraLay, Reliance Dental, USA) to the bridge serving as an anchorage for distraction osteogenesis. Following 4 months of consolidation to permit a maturation and avoid a relapse of the distracted bone, the implant site was evaluated radiographically using a cone-beam computed tomography (CBCT) system to characterize the quantity and quality of the generated bone (Figure 5). The total vertical distraction was approximately 8 mm.

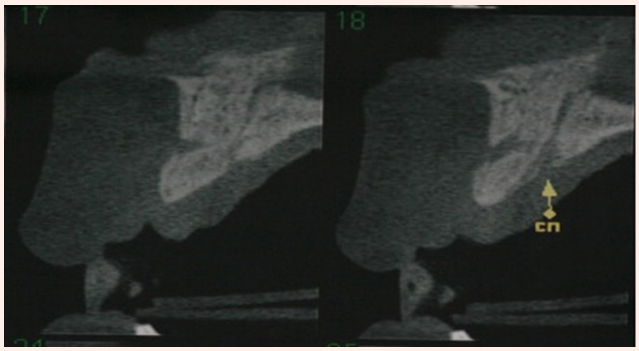


**Figure 5:** CBCT images showing the growth of bone with distraction.

The distracting capsule used to distract the alveolar bone was removed and a regular platform endosseous implant (4.1 mm x 11 mm, external hex, S.I.N. implant system, Brazil) was placed using an open flap surgery. The implant surgery was aided by a surgical guide designed according to the diagnostic wax-up (Figure 6). The implant was submerged to avoid a disruption during 4 months of healing. After verifying osseointegration, the implant was loaded with a screw-retained provisional single implant crown. The screw retained provisional crown was fashioned using a prefabricated acrylic denture tooth (Trilux, Eurovipi, Brazil) and customized with a light-cured liquid resin color modifier (Kolor + Plus, Kerr, USA) in conjunction with a prefabricated temporary titanium abutment (RP 4.1, external hex, S.I.N. implant system, Brazil). The crown was connected to the implant and tightened up to 20 Ncm using a manual torque wrench (Nobel Biocare, Switzerland), and the screw access hole was filled with gutta-percha (Dentsply, Brazil) followed by composite resin (4 Seasons, Ivoclar Vivadent, Liechtenstein) (Figure 7).

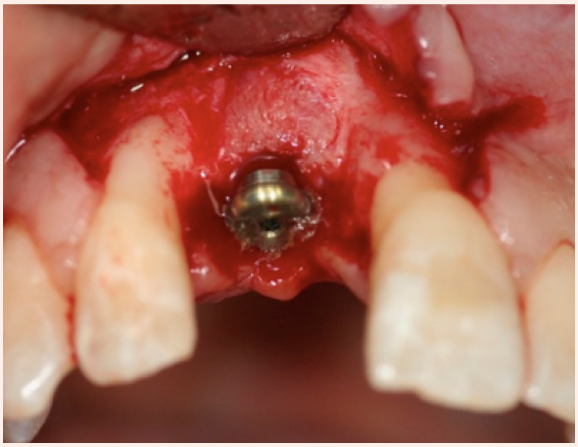

**Figure 6:** Dental implant placed in the distracted site.

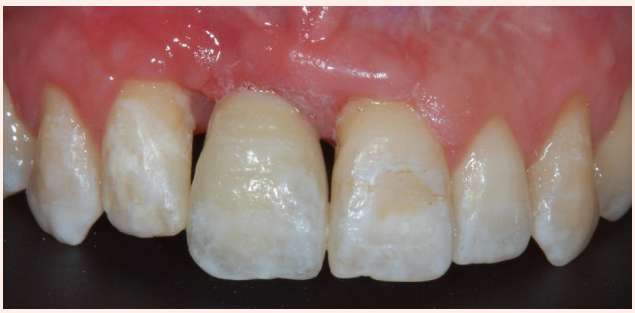

**Figure 7:** Frontal view of a screw-retained provisional crown replacing the right central incisor. Note the deficient gingival architecture and "black triangles" revealed in the interproximal area.

After obtaining an ideal emergence profile of the peri-implant mucosa, a maxillary impression was made to generate a soft tissue cast and calibrate the space distribution of the maxillary anterior teeth. Waxing was performed on the study cast to characterize an ideal distribution of the anterior teeth and optimize the architecture of the peri-implant mucosa. The goal was to restore the function and esthetics as represented by the teeth and avoid a creation of "black triangles" resulting from a deficiency of interproximal mucosa (Figure 8).

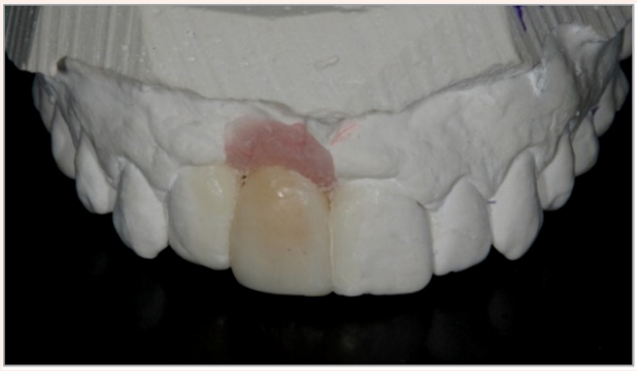

**Figure 8**: Diagnostic waxing for restoration of the anterior teeth.

A light-cured composite resin (4 Seasons, Ivoclar Vivadent, Liechtenstein) was used to recontour the mesial aspect of the right lateral and left central incisors. After etching the enamel using a phosphoric acid at 37% (Condac37, FGM, Brazil), a thin layer of adhesive resin (Adper Single Bond 2, 3M ESPE, USA) was coated for bonding composite resin. The resin was added to increase the mesio-distal dimension of the incisors and create longer proximal contacts against the proposed implant crown (Figures 9 & 10).

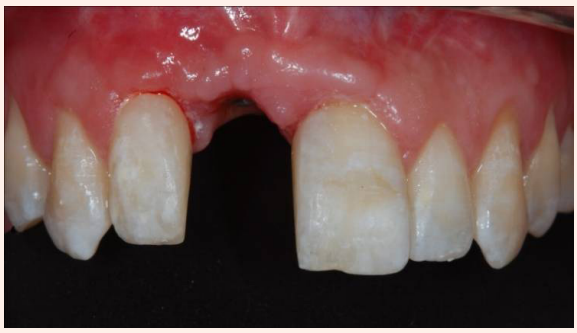

**Figure 9:** Frontal view of gingival architecture cultivated by provisional restoration and adjacent proximal embrasures recontoured with composite resin.

**Figure 10:** Abutment produced through MAD/MAN processing: resin mock-up (left) and milled zirconia abutment (right).

An open tray technique was used to make a final impression and fabricate a single implant crown for the right central incisor. A custom tray was fashioned to demonstrate a hole for a direct impression transfer coping (4.1 Impression coping open tray, external hex, S.I.N. implant system, Brazil) and guide screw. The final impression was made with a polyether impression material (Impregum Soft, 3M ESPE, USA), and a definitive soft tissue cast was obtained by using a silicone material (Gingifast Elastic, Zhermack, Italy).

A manually-aided design/manually-aided manufacturing process (MAD/MAN) (Zirkonzahn GmbH, Italy) was employed to create a customized screw-retained zirconia abutment. Following the process of MAD/MAN system, the implant abutment was designed manually using a light-cured composite resin (T-Rigid, Zirkonzahn GmbH, Italy) and a temporary plastic abutment with a metal base (RP 4.1, external hex, S.I.N. implant system, Brazil). The temporary plastic abutment was screwed onto the master cast and the resin was put in place around the abutment and cured to served as a mock-up for milling a zirconia ceramic block by using a manual milling unit (Zirkograph 025 ECO, Zirkonzahn GmbH, Italy) (Figure 11). The milled ceramic abutment was sintered in a furnace (Zirkonofen 600, Zirkonzahn GmbH, Italy) and immersed in a special liquid (Colour Liquid, Zirkonzahn GmbH, Italy) for pigmentation, as recommended by the manufacturer (Figure 12).

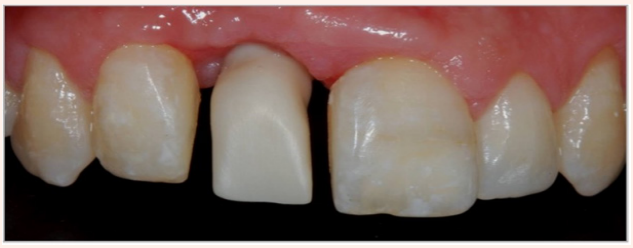

**Figure 11:** Custom milled zirconia abutment demonstrating emergence profile for porcelain build-up.

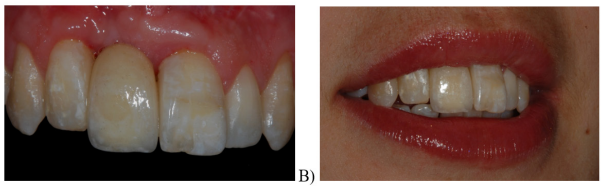


**Figure 12:** Implant-supported ceramic crown replacing the right central incisor: (A) frontal view, (B) lateral view in smile. Note the harmonious architecture of the peri-implant mucosa and absence of "black triangles" in the interproximal embrasures.

The ceramic abutment was layered with a veneering porcelain (IPS d-SIGN, Ivoclar Vivadent, Liechtenstein) to match with the adjacent teeth and enhance the translucency of ceramic restoration. Care was taken to reproduce the emergence profile designed by a provisional restoration and establish a long proximal contact to avoid a creation of "black triangle" in the interproximal with the adjacent teeth. The finished ceramic crown was screwed to the implant and tightened up to 32 Ncm using a torque wrench. The occlusion was verified to present a harmonious relation in the maximal cuspal position and no interference in excursive movements of the mandible (Figure 13). The screw access hole was sealed with a layer of gutta-percha (Dentsply, Brazil) and filled with a light-cured composite resin (4 Seasons, Ivoclar Vivadent, Liechtenstein) (Figure 14).

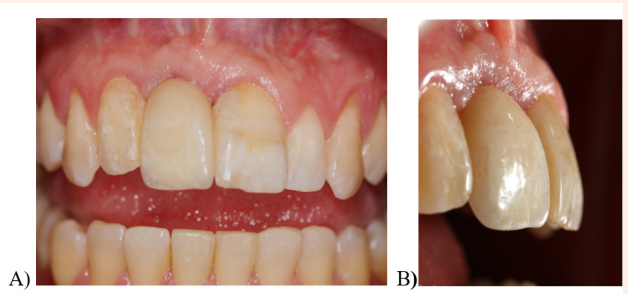


**Figure 13:** Functional and esthetic outcome of implant therapy revealed at the 10-year follow-up appointment: (A) frontal view and (B) lateral view. Note the stability of implant treatment with no signs of mechanical or biological complications.

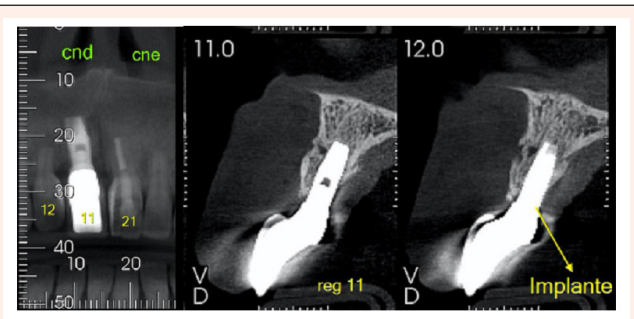


**Figure 14:** CBCT images of bony architecture revealed at the 10-year follow-up appointment. Note the stability of implant support.

The patient was instructed for maintenance and informed of possible complications with implant therapy. During the course of regular follow-up appointments, no adverse event was reported with the screw-retained ceramic crown. At the 10-year follow-up appointment, the implant was stable with no signs or symptoms of biological and/or mechanical complications.

## Discussion

Distraction osteogenesis is a surgical procedure of generating new bone by mobilizing the normal healing process of bone formation [4,9,10,13]. This procedure follows an osteotomy and gradual distraction to mobilize a bone block and enhance the implant site for a patient presenting with a bony deficiency. This method is especially useful for increasing the height of the alveolar bone without compromising the overlying soft tissue and blood supply [1,6,17]. According to previous reports, bone formed by distraction may be more stable and successful compared to the ones augmented by other surgical procedures, such as guided bone regeneration, onlay graft, or bone morphogenic protein (rhBMP-2) [1,4,14]. In addition, this method of bony distraction can reduce the risk of post-operative morbidity because of an induction of natural bone formation [4,6,9,10,13,15,17].

However, the use of this useful procedure is often hindered by the presence of the distraction device extended above the osteotomy site [1,15]. In the present case, a distracting capsule was used to engage the segmented alveolar bone and expedite the process of distraction. A key element of this procedure included a diagnostic

waxing to fabricate a resin bridge to restore the missing span as a pontic and serve as an anchorage by means of a prosthetic screw. The screw was secured to the bridge and was driven to engage the distracting capsule and mobilize the osteomized alveolar bone. The configuration of this design was to orient the bony distraction according to the diagnostic waxing and enhance the patient's cooperation by restoring the missing span in the esthetic zone of the anterior maxilla.

Implant stability is one determining factor for osseointegration warranting the functional longevity of an implant-supported crown [2,4]. According to Bilbao et al. [4] endosseous implants placed in bone generated by distraction may show functional stability comparable to the ones placed in native bone [16]. However, a consolidation of distraction is needed to characterize the trabecular pattern for implant therapy and maintain stability of newly generated bone without collapse or fracture [9,14,17]. In the present case, care was taken to avoid an infection around the distractor with an instruction of meticulous oral hygiene during the 4-month consolidation period [14].

The marginal bone around the implants placed in distracted sites appears to be as stable as the implants placed in non-distracted sites [2,17]. According to Pérez-Sayáns, 2 implants (8-13 mm in length) placed in the site of distraction may show a loss of marginal bone after 1 year of functional loading. However, the mean loss of bone occurring during the first year of functional loading was only 0.64 mm where 35% implants showed no bone loss and 57% exhibited ≤0.25 mm [2]. Whereas the pattern of bone loss may not be similar among individuals demonstrating various confounding factors such as crown-implant ratio, number of implants, and occlusion [11]. Nonetheless, distraction osteogenesis appears to be more predictable than guided bone regeneration procedure in keeping the peri-implant marginal bone and enhancing the success rate [14]. According to Chiapasco et al. [14] implants placed in areas reconstructed with guided bone regeneration showed a greater bone loss than ones placed in distracted sites.

In this clinical report, the implant-supported ceramic crown placed in the esthetic zone of the anterior maxilla was found to be stable with no distinct bone loss at 10-year follow-up appointment. The peri-implant mucosa mobilized through the distraction and characterized by means of a provisional crown was found to demonstrate a stability without compromising the emergence profile of the screw-retained ceramic crown. In addition, no "dark triangle" was shown in the interproximal embrasure. The proximal contacts were intact with no sign of migration or displacement [19]. In essence, the implant support crown was found stable with no sign of biological or mechanical complications during the 10-year follow-up [6,11].

## Conclusion

Implant therapy for an esthetic zone in the anterior maxilla requires bony augmentation when the implant site demonstrates a deficiency of alveolar bone. This 10-year follow-up clinical report presented a functional and esthetic outcome of the screw-retained single implant ceramic crown designed to restore the maxillary right central incisor. The long-term success of this therapy was obtained in conjunction with a segmental distraction osteogenesis conducted using a distracting capsule and a resin bridge fashioned to restore the functions and esthetics in the anterior maxilla during the process of bone formation.

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