Guided auto-transplantation of a supernumerary tooth into a surgically created socket using osseodensification and a palatal connective tissue graft: a case report

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Running title: Guided auto-transplantation

Funding: This report received no funding**.**

Conflict of interest: The authors deny any conflicts of interest related to this report study.

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Abstract

This case report describes the replacement of a missing maxillary right central incisor (tooth #8) with a supernumerary tooth using cone beam computed tomography (CBCT) based digital planning, a three-dimensional (3D) printed donor replica tooth, osseodensification, and connective tissue grafting. A 36-year-old male presented with general periodontitis and a healed socket in the #8 region 3 months post-avulsion. Based on CBCT scans, auto-transplantation of a single-rooted mandibular supernumerary tooth into a surgically created socket in the #8 region was planned. Root canal treatment was performed on the donor tooth prior to its extraction. Digital planning was performed, and a 3D replica of the donor tooth was designed and printed. The surgically created socket was prepared with an osseodensification technique. Extraction of the donor tooth was performed atraumatically, and soft tissue grafting and splint stabilization was performed after its placement in the socket. A definitive crown was placed at 12 months. At 30 months the transplanted tooth was functional and asymptomatic, with no clinical or radiographic signs of apical pathosis.

Keywords: Tooth autotransplantation; surgically created socket; supernumerary tooth; osseodensification; CBCT planning.

Introduction

Auto-transplantation provides distinct biological and functional advantages over dental implants when replacing missing teeth. By preserving the periodontal ligament (PDL), the transplanted tooth provides proprioception, allows physiological tooth movement, and supports uninterrupted skeletal growth.[1] The donor tooth can be placed in a fresh/recent extraction socket or into a surgically created socket. Several factors affect the outcome of tooth auto-transplantation, such as the stage of root development, recipient site features (local inflammation, alveolar bone volume and quality), type of socket (fresh/surgically created), the surgical procedure (stabilization method, use of intraoperative drugs and storage) and general surgical trauma.[2,3,4] The pooled success rate of auto-transplantation has been reported to be 94% over follow-up periods ranging from one month to twenty-nine years.[5] Donor teeth with mature apices have predictable outcomes with high overall survival rates of up to 96%.[6] Auto-transplantation techniques requiring socket modification have a success rate of approximately 91% in comparison to that of transplantation into a fresh extraction socket (97%).[5]

Various tooth types can be used as donor teeth; however, the use of a supernumerary donor tooth for auto-transplantation into an edentulous region, although not common, is a biologically oriented therapeutic option for replacing missing teeth. This approach addresses two concurrent dental abnormalities, hyperdontia and hypodontia, in a minimally invasive single biologically tailored treatment approach.[7] The removal of a supernumerary tooth resolves issues such as the mandibular anterior excess where the mesiodistal widths of maxillary and mandibular teeth are not proportionate. In addition, the transplant simultaneously fills an edentulous space in the arch.[7] Despite this, there are only a small number of documented cases in which an auto-transplantation approach using a supernumerary tooth as a donor was carried out.[8,9]

Digital Imaging and Communications in Medicine (DICOM) files are provided by cone-beam computed tomography (CBCT) scans for the purpose of virtual planning. These files enable the optimal location, angulation, and depth of the donor tooth in the recipient site to be calculated.[10] As a consequence of this digital planning, clinical success is improved through the use of three-dimensional replicas of the donor tooth as they minimize periodontal ligament damage and the extraoral time.[11] It has been reported that in 82% of such cases, the transplantation was performed with an extra-alveolar time of

less than one minute and with an immediate good fit of the donor tooth achieved.[12] To date, using 3D replicas for auto-transplantation of supernumerary teeth has been reported only in young patients undergoing orthodontic treatment. Auto-transplantation of supernumerary donor teeth along with connective tissue graft to compensate for soft tissue deficiencies at the recipient site with the aid of 3D replicas of donor teeth has not been reported in adult patients.

Osseodensification is a novel osteotomy technique used when placing dental implants that employs a bone preservation method to create a layer of compacted bone along the surface of the osteotomy in order to increase primary stability, bone mineral density, and the percentage of bone along the implant surface.[13] Similarly, to ensure optimum healing and esthetics, auto-transplantation can be combined with a simultaneous palatal connective tissue graft to reconstruct any soft tissue defects. This graft increases the band of keratinized gingiva and the thickness of buccal soft tissue, protecting the underlying bone block.[1]

This case report describes the guided auto-transplantation of a right mandibular supernumerary tooth into a surgically prepared socket in the maxillary anterior region using a 3D replica combined with an osseodensification technique and palatal connective tissue graft.

Case Report

The Preferred Reporting Items for Case reports in Endodontics (PRICE) 2020 standards were followed in the preparation of this report.[14] The PRICE flowchart (Supplementary Fig 1) provides the key features of the case.

A 36-year-old male reported to the dental clinic in March 2023 seeking replacement of a missing maxillary right central incisor (#8) (Fig 1A). The patient gave a history of a traumatic injury three months earlier when tooth #8 was avulsed. He had no systemic health conditions and was a non-smoker. Clinically, the alveolar ridge in the #8 region was reduced in height and width, with periapical radiographs confirming loss of bone in the region (Fig 1B). In addition, the patient had generalized stage II, grade B periodontitis. Five supernumerary teeth were identified, two in the maxillary left premolar region, one in the mandibular right premolar region, and two in the mandibular left premolar region (Fig 1C-F).

Treatment options such as a dental implant, fixed bridge and auto-transplantation of a supernumerary tooth were discussed, with the patient finally consenting for auto-transplantation. The treatment was performed in the following five stages:

1. *CBCT procurement, digital planning and static osteotomy guide / replica printing*

Details of the digital planning and printing of a donor tooth replica have been described previously.[11,15] In brief, a CBCT scan (16 × 16 cm, Carestream CS 8100 3D, Carestream Dental LLC, Atlanta, GA, USA) confirmed the reduced volume of the alveolar ridge in the #8 region (Fig 1G,H) that would have complicated implant placement. A supernumerary tooth with a mature apex in the mandibular right premolar region was identified as the best donor tooth. The mesiodistal and the buccolingual widths of its crown were 6.8 mm and 7.2 mm respectively, which matched to the width of the space in the #8 region. The procured images were stored in DICOM format. An intraoral scan was performed using a TRIOS 3 intraoral scanner (3Shape, Copenhagen, Denmark) and saved in STL format. The DICOM and STL images were superimposed, and the treatment planning was performed using BlueSkyPlan v4.13 (BlueSkyBio LLC, Libertyville, IL, USA) (Fig 2A-D). Both the donor tooth replica (Fig 2E) and the static osteotomy guide were printed using Surgical Guide Resin (Formlabs Inc., Somerville, MA, USA), a Class I biocompatible resin certified for intraoral surgical applications.

2. *Root filling of donor tooth*

Prior to extraction and under mepivacaine anesthesia and rubber dam isolation, the donor tooth underwent root canal treatment (Fig 2F, G). Root canal instrumentation was performed with Reciproc Blue R25 (VDW GmbH, Munich, Germany), and the canals were irrigated with 5.25% sodium hypochlorite agitated with EndoActivator® (Dentsply Sirona, Ballaigues, Switzerland). A final rinse with 17% EDTA solution (SmearClear®, SybronEndo, Orange, CA, USA) was performed. The canal was filled with gutta-percha (Reciproc R25; VDW GmbH, Munich, Germany) and Fillapex® sealer (Angelus, Londrina, Brazil). The access cavity was restored with resin composite (Ceram·X A2, Dentsply Sirona, Ballaigues, Switzerland).

3. *Creation of the socket*

The static osteotomy guide (Fig 3A) was designed to orientate the osteotomy preparation in the fully healed recipient socket. A full thickness mucoperiosteal flap was elevated in

the #8 region to expose the alveolar bone. The fit and stability of the prefabricated static osteotomy guide were verified intraoperatively. Guided osteotomy was performed using a 2.2 mm stainless steel twist drill (Straumann®, Basel, Switzerland) under copious sterile saline irrigation and verified radiographically.

Subsequently, osseodensification was carried out with Densah® burs (Versah LLC, Jackson, MI, USA) in reverse (counterclockwise) mode at 1100 rpm with profuse irrigation to achieve gradual bone expansion and compaction of the socket walls (Fig 3B). This allowed for enhanced primary stability of the donor tooth and preservation of crestal bone architecture. The printed donor tooth 3D replica was tested sequentially (Fig 3C) during site preparation to confirm the accuracy of socket morphology and to minimize the extra-alveolar time of the donor tooth.

4. *Extraction and auto-transplantation*

The donor tooth was extracted (Fig 3D) atraumatically under local anesthesia with 4% articaine with 1:100,000 epinephrine (Ubistesin™, 3M ESPE, Seefeld, Germany) and systemic antibiotic coverage (Amoxicillin 500 mg for five days, Amoxicilina Normon®, Madrid, Spain) and transplanted to the prepared #8 site. The soft tissue defect and the short band of keratinized gingiva were simultaneously managed using a connective tissue graft harvested from the palate (Fig 3E). The graft was obtained using a single-incision trap-door technique with a 15C surgical blade (Hu-Friedy, Chicago, IL, USA) and carefully dissected to the desired thickness. The dimensions were determined intraoperatively, focusing on the thickness needed for optimal soft tissue volume augmentation and contour establishment. It was adapted and placed on the labial side of the recipient site to increase the band of keratinized gingiva and reconstruct the soft tissue defect.[16] The graft was adapted to the recipient site and sutured with 5-0 monofilament polypropylene sutures (Prolene®, Ethicon, Somerville, NJ, USA). Following the repositioning of the mucoperiosteal flap, closure was achieved with sutures. Both a triple-twisted orthodontic ligature with a gauge of 0.12 and a resin composite were used to stabilize the donor tooth (Fig 3F, G). After the procedure, the patient was prescribed ketoprofen 10 mg (Adolquir®, Kern Pharma, Barcelona, Spain) and instructed to adhere to a soft diet and ensure careful oral hygiene.

5. *Tooth restoration and follow-up*

The patient was first reviewed at 2 weeks for suture removal. At 4 weeks, the splint was removed, and a provisional acrylic crown was placed to maintain function and esthetics. At 2-months, the transplanted tooth was asymptomatic, had normal mobility (Grade I or less), and radiographs confirmed satisfactory bony healing with preservation of the periodontal ligament space and no signs of root resorption or apical pathosis (Fig 4A). The tooth was functional and stable at the 12-month follow-up, with radiographic evidence of complete bone fill around the socket and restoration of the lamina dura (Fig 4B). There was no ankylosis, and the periodontal ligament space was continuous. A definitive monolithic zirconia crown (Zenostar®, Ivoclar Vivadent, Schaan, Liechtenstein) was fabricated and cemented at this time (Fig 4C). The transplanted tooth remained asymptomatic, esthetically integrated, and functional at the final 30-month follow-up. The soft tissues exhibited a healthy band of keratinized gingiva as a result of the connective tissue graft, and clinical periodontal probing depths were within normal limits (≤3 mm). Mobility of the tooth was physiologic. On the periapical radiographs (Fig 4D, E), the crestal bone levels were stable, the periodontal ligament space was preserved, and there was no evidence of inflammatory or replacement resorption. The patient is being maintained on a strict periodontal maintenance program every 6 months due to generalized periodontitis.

Discussion

The prevalence of supernumerary teeth is estimated to be between 2.4 and 6%, with males having a greater chance of this anomaly.[17] It is uncommon to have multiple supernumerary teeth, which can be linked to a number of genetic syndromes[18] or non-syndromic conditions, such as oro-facial clefts.[19] Several reports suggest that supernumerary teeth, such as mesiodens and anterior teeth, can be used as donors for auto-transplantation using 3D replicas.[7,9,20] However, the use of a supernumerary tooth with a mature apex from the mandibular premolar region to replace a maxillary anterior tooth with soft and hard tissue deficiencies has not been documented.

Pulp revascularization is unlikely to occur following the auto-transplantation of teeth with completely formed roots.[21,22] Consequently, root canal treatment is an essential step that can completed prior to, during, or subsequent to its transplantation. Nevertheless, the extra-oral time and the potential for periodontal ligament cell damage to the root surface will be increased when root canal treatment is administered during

transplantation. Therefore, in the current case, root canal treatment was carried out prior to the extraction and was uneventful because of its single root and canal.

Despite the absence of a periodontal ligament in the surgically created socket, the transplanted tooth exhibited advanced periodontal ligament and bony healing. This may be due to the limited extraoral time between extraction and implantation in the socket and the use of a connective tissue graft to address the soft tissue defect. The optimal adaptation of the prepared socket for the donor tooth was facilitated by its 3D replica,[11,23] it also ensured minimal damage to the root surface which would otherwise have occurred because of repeated try-ins of the actual tooth.[24]

To prevent root surface injury during donor tooth placement, the surgically prepared socket must be sufficiently large while still being closely adapted to the dimensions and shape of the tooth. A prolonged period of time is required for fibrous bone to fill the gap between the socket and the donor tooth when the space is large. In fact, a space of 1–2 mm has been reported to promote favorable healing[24] because this optimal contact will enhance the blood supply and nutrition of the periodontal ligament cells remaining on the root of the donor tooth.[25]

The virtual planning enabled the precise placement of the donor tooth and the simultaneous combination of a connective tissue graft and osseodensification osteotomy in the recipient socket, which had an extensive bone defect. This approach is a novel feature of this fully guided auto-transplantation. The densifying burs have a large negative rake angles, which act as non-cutting edges resulting in the smooth compaction and increased density of bone during the drilling rather than the bone removal normally associated with the use of a bur.[13] This technique utilizes the viscoelastic property of bone and allows controlled bone deformation due to the rolling and sliding contact of the rotating bur with the inner wall of the osteotomy site. This subsequently causes a “spring-back” effect in the bone at the osteotomy site resulting in a smaller socket compared to the size of the bur. This technique has shown to increase the stability of dental implants by generating residual strain and compressive stresses.[13] It was hypothesized that this technique would increase the stability and approximation of the donor tooth in the recipient socket. The process also allowed autografting of bone particles along and at the base of the socket.[13] It has been reported that the percentage of bone along implant

surfaces was increased by approximately three times for implant sockets prepared with osseodensification compared with standard drilling.[13]

Use of a 3D replica prevented the need to use the donor tooth when assessing its fit into the surgically created socket. This minimized trauma to the periodontal ligament and enhanced the healing outcome,[11] and could be considered a strength of the case. However, the report focusses only on one case, which could be interpreted as a limitation because it does not provide the most comprehensive evidence regarding the treatment outcome in a wide range of patients. As a result, to confirm this treatment approach is an appropriate option in clinical practice, it will be necessary to conduct long-term clinical investigations in the future.

Conclusion

This case report details the successful replacement of a missing maxillary right central incisor with a mandibular right supernumerary tooth. The transplanted tooth continued to function and exhibit favorable esthetic results at the 30-month follow-up.

Figures

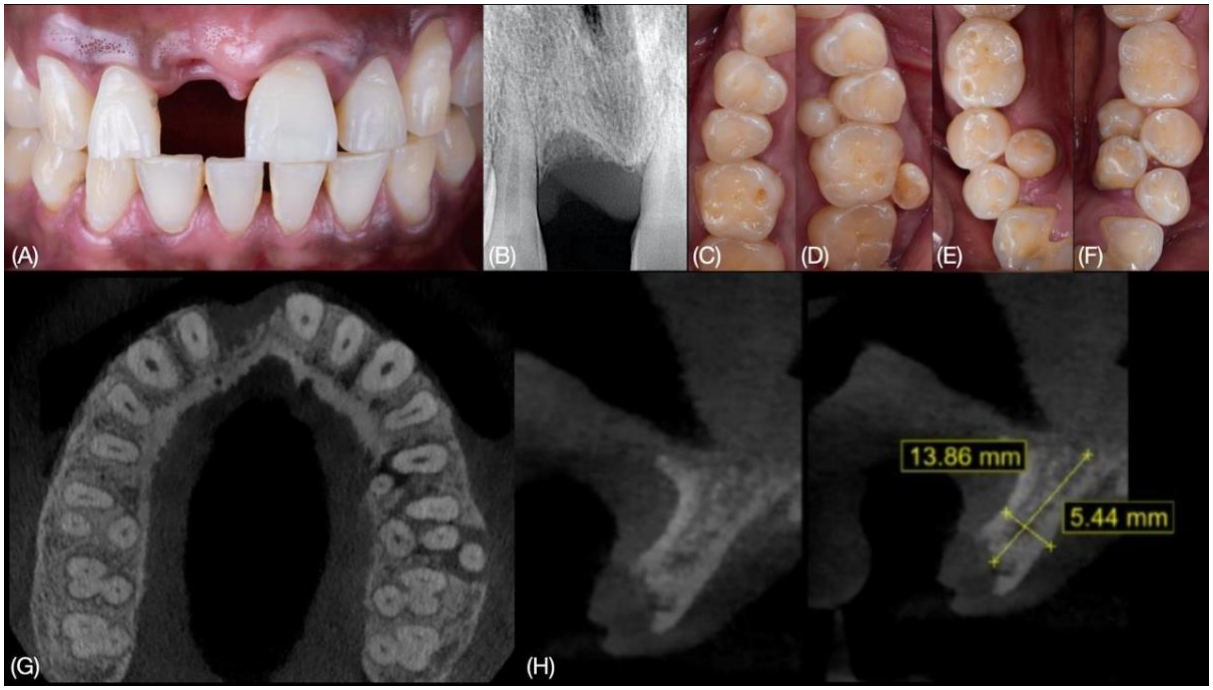

Figure 1: Preoperative view with absence of the maxillary right central incisor (#8) and multiple supernumerary teeth. (A) Frontal intraoral view of the healed socket at the #8 site; (B) Periapical radiograph of the #8 region with reduced alveolar bone height; (C) Maxillary right premolar region showing alignment of the permanent dentition with no supernumerary teeth; (D) Maxillary left premolar region showing two supernumerary teeth located in the premolar region; (E) Mandibular right premolar region with one supernumerary tooth in the premolar area; (F) Mandibular left premolar region with two lingually positioned supernumerary teeth in the premolar region; (G) Axial CBCT slice obtained with a large-volume scanner to assess the alveolar defect in the # 8 region and to identify potential supernumerary donor teeth for autotransplantation; (H) Sagittal CBCT slices of the #8 region showing a deficiency in the vertical dimension (13.86 mm) and buccolingual width (5.44 mm), allowing evaluation of donor–recipient compatibility and treatment feasibility.

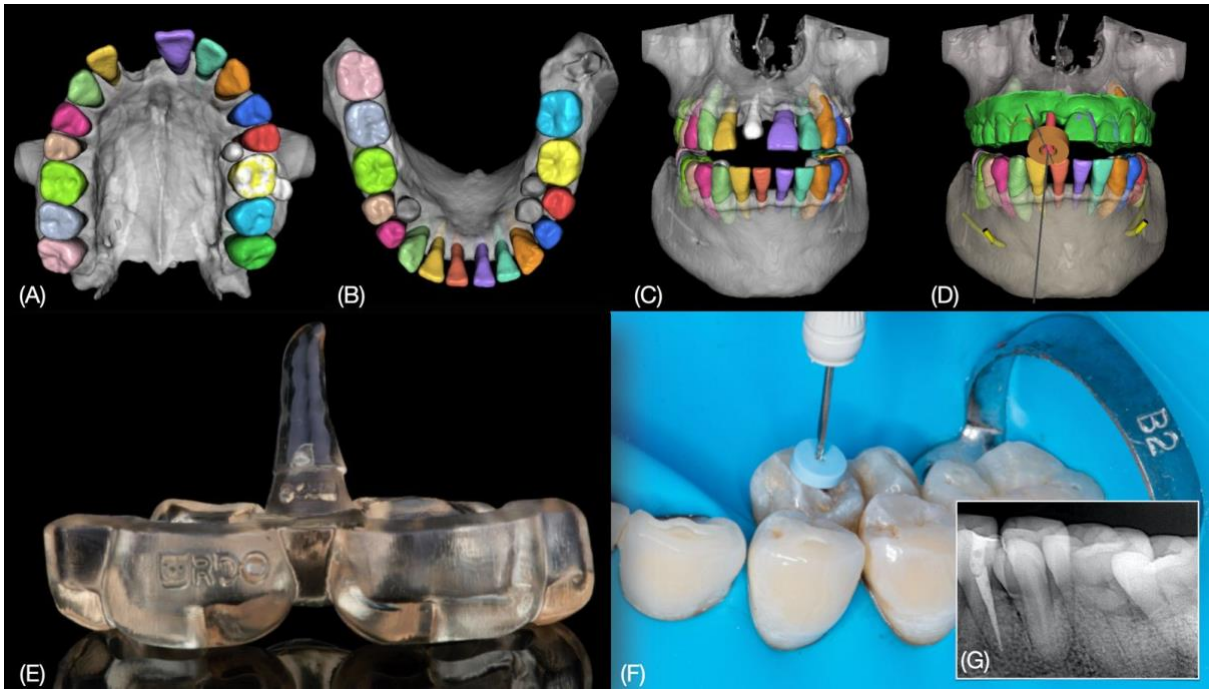

Figure 2: Digital planning workflow for the selection and preparation of the donor tooth. (A) 3D segmentation of the maxillary dentition; (B) 3D segmentation of the mandibular dentition; (C) Simulation of the optimal 3D position of the selected donor tooth in the recipient site, based on morphological compatibility and spatial fit; (D) Computer-aided design (CAD) of a surgical guide for osteotomy orientation; (E) 3D-printed position guide incorporating a replica of the donor tooth to transfer the planned position to the surgical field; (F) Root canal treatment of the donor tooth prior to transplantation due to complete root formation; (G) Postoperative periapical radiograph showing the root filling in the transplanted tooth.

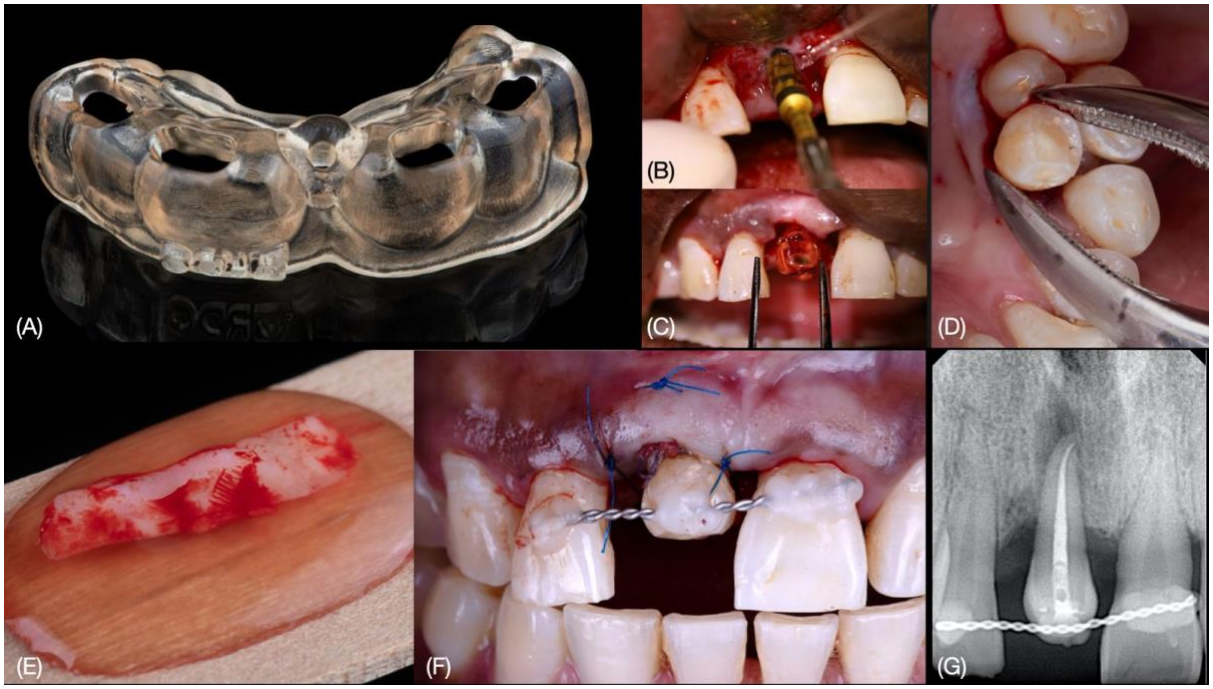

Figure 3: Surgical procedure of the auto-transplantation. (A) Printing of the surgical guide; (B) Osteotomy performed with osseodensification burs (Versah LLC, Jackson, MI, USA); (C) Try-in of the 3D-printed donor tooth replica to verify socket shape and depth; (D) Atraumatic extraction of the supernumerary donor tooth using only forceps; (E) Connective tissue graft harvested from the palate; (F) Donor tooth positioned in the recipient socket, stabilized with wire–composite splinting, and covered with the connective tissue graft on its labial aspect; (G) Immediate postoperative periapical radiograph.

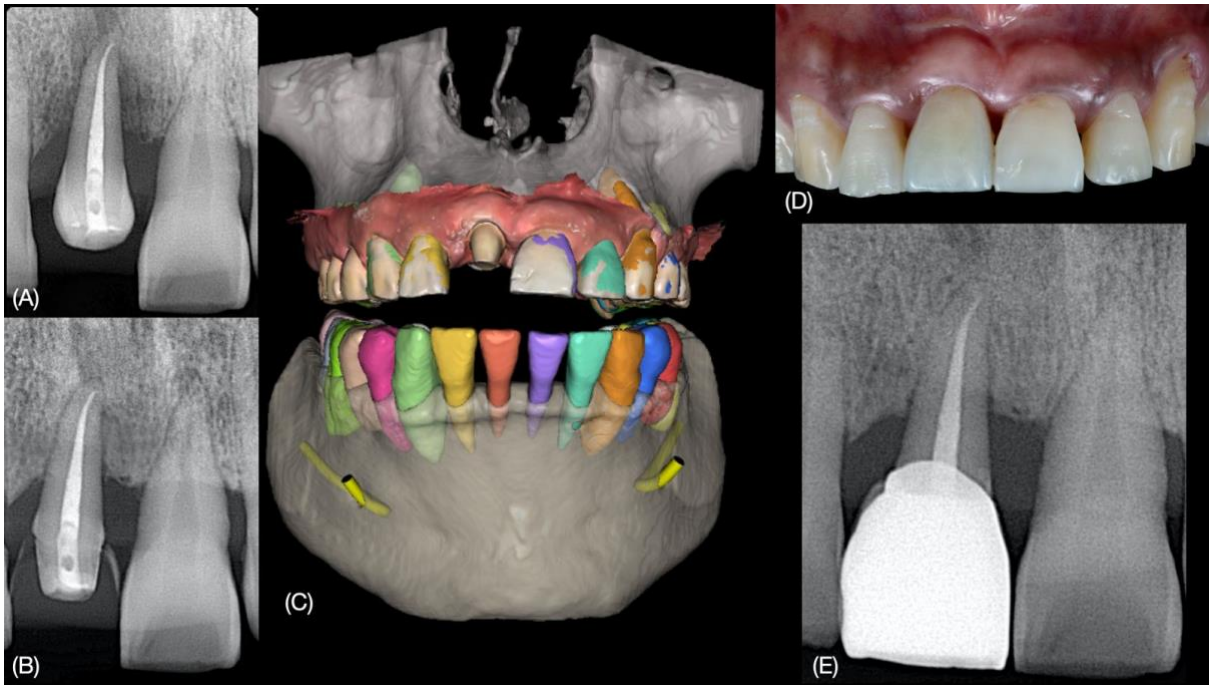

Figure 4. Follow-up and definitive restoration of the donor tooth. (A) 2-month periapical radiograph showing socket healing and periodontal ligament space preservation; (B) 12-month periapical radiograph with retained periodontal ligament space, intact lamina dura, no root resorption, and no periapical pathosis; (C) 12-month intraoral scan for definitive monolithic zirconia crown fabrication; D) 30-month clinical view of the cemented crown with harmonious gingival structure; (E) Periapical radiograph after 30 months with intact lamina dura, and no apical pathosis or replacement resorption.

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