Guided autotransplantation of an immature premolar to the maxillary incisor region with satisfactory esthetic outcome - A case report

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Guided autotransplantation of an immature premolar to the maxillary incisor region with immediate restoration of esthetics - A case report

ABSTRACT

This case report describes the treatment of two maxillary central incisors following a traumatic injury with tooth #8 developing replacement resorption and #9 developing inflammatory root resorption. A 10-year-old girl presented complaining of pain in her maxillary central incisors. Upon clinical examination, teeth #8 and #9 were tender to percussion and palpation of the buccal soft tissues. Thermal and electrical pulpal sensitivity tests for teeth #8 and #9 were negative. An intraoral periapical radiograph revealed resorptive defects in tooth #8, which were filled with bone-like tissue, while tooth #9 had radiolucent resorptive defects along the root surface and a periapical radiolucency. A diagnosis of replacement resorption was made for tooth #8 and external inflammatory root resorption for tooth #9. Tooth #8 was treated with a multidisciplinary approach utilizing a guided template for premolar autotransplantation with an immediate veneer restoration, while the tooth #9 was managed with root canal treatment using a tricalcium silicate cement to fill the canal. At the 1, 4, 8, 12, and 24-month follow-ups, the patient remained asymptomatic, and there was no radiographic evidence of root or periapical pathosis on either tooth. The root-end of the donor tooth transplanted to the #8 site continued to develop. This case report highlights successful interdisciplinary management of two forms of root resorption using modern treatment strategies that provided immediate function and esthetics to the maxillary central incisors in a young patient following trauma.

Statement of Clinical relevance

This case report describes the successful interdisciplinary management of two forms of root resorption in a young patient who experienced a traumatic dental injury to. their maxillary anterior teeth. These contemporary treatment methods immediately restored function and esthetics.

Introduction

External root resorption can be categorized as inflammatory or replacement based on the tissue response to the injury [1]. Inflammatory root resorption (IRR) is a result of clastic action caused by microbes and is characterized as radiolucent areas along the root surface. Two management strategies have been proposed for IRR namely, preventive and interceptive, where the interceptive strategy uses therapeutic options after the initiation of the IRR [2]. Replacement resorption is managed by placing the tooth under observation in older patients since the progression is slower. However, in young patients intentional decoronation has been suggested as a management strategy with the aim of preserving the bucco-palatal dimension as well as vertical growth of the alveolar ridge to aid in implant placement at a later date [3,4]. Surgical repositioning, composite buildup of infra-occluded teeth and distraction osteogenesis are some of the treatment options suggested for teeth with replacement resorption [5]. However, data on treatment outcomes is limited with these techniques.

Autotransplantation of premolars has been considered as a treatment option for unsavable teeth with extensive replacement resorption [6,7]. Autotransplantation of teeth provides a range of advantages such as the presence of a viable periodontal ligament fibroblast (PDL), the continuation of alveolar growth, and maintenance of the contour and shape of the attached gingiva [8]. Teeth with immature roots have the potential to benefit from pulp revascularization and continued root development [8]. Advances in digital technology and computer aided design and machining allows clinicians to plan and execute tooth autotransplantation. An autotransplant using a tooth-shaped osteotome that was custom designed for teeth with ankylosis was associated with excellent healing after 18 months [9].

In the maxillary anterior region, autotransplanted teeth should be restored or reshaped without delay for esthetic and psychological purposes[10]. However, such restorations are seldom carried out immediately following tooth transplantation due to the possibility they would impede the healing process[11]. Computer aided design-computer aided manufactured (CAD-CAM) templates for tooth autotransplantation with immediate esthetic rehabilitation for replacement resorption has not been documented in the literature.

The case described in this report involves two maxillary central incisors which presented with different types of root resorption after dental trauma. A multidisciplinary approach using a CAD-CAM guided template for premolar autotransplantation for the tooth with replacement root resorption with an immediate poly (Methyl methacylate) (PMMA) interim veneer restoration and the use of tricalcium silicate cement as a root filling material for the tooth with inflammatory root resorption is reported.

Case report

A 10-year-old girl with a history of a traumatic dental injury 8 months previously was referred to a private dental clinic in Barcelona, Spain in 2020. The patient complained of pain from the maxillary central incisors over a period of 2 weeks, which had gradually increased in intensity in the days prior to her attendance.

Trauma history

Tooth #8 had been avulsed due to a sports injury and had an extra oral dry time of more than 2 hours. Immediately following the injury, the tooth was replanted and a semirigid splint was placed for 4 weeks. Tooth #9 had a non-complicated crown fracture and had been restored with resin composite by a general dentist.

Preoperative clinical and radiographic examination

On clinical examination, tooth #8 was in infraocclusion by 3mm and teeth #8 and #9 were restored with resin composite (Fig. 1A). The patient gave a history of attempted root canal treatment on tooth #8. The patient had a Class II malocclusion with vertical maxillary excess. The teeth were tender to percussion as well as on palpation of the buccal soft tissues. Thermal and electric pulpal sensitivity tests were negative for both teeth. Tooth #8 had a metallic tone on percussion. An intraoral periapical radiograph of #8 revealed complete canal calcification and resorptive defects along the external surface of the root (Fig. 1B), which was replaced with bone like tissue. Radiolucent resorptive defects were evident along the root surface on CBCT scans (Fig. 1C-F) as well as a periapical radiolucency (Fig. 1B) on #9 (PAI score 4).

Diagnosis and treatment plan

A diagnosis of replacement resorption on #8 and external inflammatory root resorption on #9 was made. The treatment plan of root canal treatment with complete canal filling

using tricalcium silicate cement in #9 and guided tooth autotransplantation with immediate esthetic rehabilitation of #8 was discussed with the patient's parents. Prior to the procedure, written consent from the parents as well as a verbal assent from the child was obtained.

Treatment procedure

Management of tooth #9

Under dental dam isolation, an access cavity was prepared in tooth #9 with an Endo Access Bur (Dentsply Sirona, Maillefer, Ballaigues, Switzerland) and Endo-Z Bur (Dentsply Sirona). Using an apex locator (Root Zx Mini, Morita, Kyoto, Japan) and periapical radiographs, the working length was determined. The root canal was instrumented circumferentially with K-files (Dentsply Sirona) and a calcium hydroxide medicament (Calcicur, Voco GmbH, Cuxhaven, Germany) placed for 15 days. At the subsequent appointment, the patient was asymptomatic, and the medicament was removed using passive ultrasonic irrigation (Acteon Satelec, Merignac, France) and 17% EDTA as adjunct. The canal was disinfected with 50 mL of 5 % sodium hypochlorite and 17% EDTA using the Endovac irrigation system (Sybron Endo, Oregon, CA, USA). The canal was finally rinsed with ethanol, dried with paper points and filled entirely with Biodentine (Septodont, Saint-Maur-des-Fossés, France) using Schilder pluggers (Dentsply Sirona) (Fig 1G).

Tooth #9 was managed as an emergency with no CBCT device being available at the clinic, thus the decision to use CBCT for planning the tooth autotransplant to replace #8 was deferred till the treatment of tooth #9 had been completed.

Guided tooth autotransplantation using a single-rooted second premolar in the #8 region after extraction

A guided tooth autotransplantation using a single rooted second premolar was planned in the #8 region after its extraction. This procedure for managing a tooth with alveolar bone loss due to luxation has been explained in detail[12]. In brief, the procedure was performed in the following stages: planning the positioning of the autotransplant, designing the guided template, *in situ* veneer preparation on the donor tooth and intraoral scanning, fabrication of the veneer, extraction of the resorbed tooth, preparing the

transplant site, extraction of the donor tooth, extraoral luting of the veneer on the donor tooth, and its placement in the recipient site.

Planning of the autotransplant position was performed based on medium-volume CBCT images (Ortophos SL 3D, Dentsply), which were acquired with an 8x8 cm a field of view using 70 kVp and 6.3 mA and 0.18 mm voxel size (Fig. 2A). The bone dimensions of the recipient site as well as the crown and root length of the donor tooth (maxillary left second premolar) were assessed. The crown of tooth #13 measured 9 mm occluso gingivally and 7 mm mesiodistally. From the Digital Imaging and Communications in Medicine (DICOM) files of the CBCT images, the donor tooth was segmented to generate the autotransplanted tooth replica as a stereolithographic (STL) file using a software (NemoScan; Nemotec, Madrid, Spain) (Fig. 2B-D). The precise 3D position of the donor tooth at the recipient site was determined, based on the anatomical space and surrounding structures (Fig. 2E and F).

The buccal part of the tooth #8 was digitally segmented to create a virtual veneer (Fig. 2G-K). The donor tooth #13 was prepared intraorally for a veneer restoration and the occlusal surface was reduced and finished with a bevel. The intraoral veneer preparation was scanned with an intra oral scanner (Medit i500, Medit corp., Seongbuk-gu, South Korea). A 3D replica of tooth #13 with the veneer was printed using a biocompatible resin **(**Denture Teeth Resin, Formlabs Inc., Somerville, Massachusetts, USA**)** on a stereolithography 3D printer (Form 3B, Formlabs Inc). A 3D-guiding template was also designed and printed with a transparent biocompatible resin (Dental LT clear resin, Formlabs Inc.,) to determine exactly the correct position of the donor tooth in the recipient socket (Fig. 3A). The donor tooth replica was used for socket modification after extraction of #8. A washing machine filled with isopropyl alcohol (96%) was used to wash the 3D-printed models (Form Wash; Formlabs Inc) for 20 minutes and later cured in a curing machine (Form Cure; Formlabs Inc) for 20 minutes at 80°C. The interim veneer which replicated the shape of the donor tooth was milled using a Poly Methyl Metha Acylate (PMMA) disk (PMMA 98 multilayer A2, Dentsply Sirona) with a milling machine (inLab MC X5; Dentsply Sirona) (Fig 3B and C).

Tooth #8 was anesthetized with 1.8 mL of 2% lidocaine and 1:100,000 epinephrine (Norman, Madrid, Spain) using a 27-gauge needle. Tooth #8 was extracted atraumatically (Fig. 3D and E) and an 8 mm deep osteotomy was performed in the socket using an implant drill (Fig. 3F) (Klockner system, Barcelona, Spain). The 3D replica of tooth #13 was placed in the socket to assure its correct position (Fig. 3G). The donor tooth was removed atraumatically (Fig. 3H and I) and the veneer was luted extraorally with a resin cement (Relyx Unicem 2 Automix Universal, 3M ESPE, St. Paul, MN, USA). During this one-minute procedure, the root of the donor tooth was immersed in saline solution and protected by placing a dental dam at the cementoenamel junction.

The donor tooth with the veneer was placed in the socket and splinted using a semi-rigid titanium splint (Fig. 3 J-L) for four weeks (Fig. 3L). Postoperatively the patient was advised to take a soft diet and Amoxicillin 500 mg as well as Ibuprofen 300 mg were prescribed.

Follow-up

The patient was followed up at 4 weeks to remove the semirigid splinting and then at 1, 4, 8 and 12 months. No signs of pain, mobility, and sinus tract were present in relation to tooth #9 and the autotransplanted tooth. Intraoral radiographs revealed periapical healing and the progression of root formation on the autotransplanted donor tooth (Fig. 4 A-D) with no root resorption. At the end of 12 months, signs of root canal obliteration were observed in the autotransplanted tooth. Apical healing was observed on tooth #9 as well as the arrest of resorptive activity with no new resorptive defects being visible (Fig 4A-D). At the end of 12 months, the contralateral maxillary second premolar was extracted, and orthodontic treatment was initiated to correct the Class II division 1 malocclusion with mild lower anterior crowding (Fig 4E). At the 2-year follow-up, both the teeth were asymptomatic with no pain, swelling, mobility, discoloration, and with periodontal probing depths within normal limits. The autotransplanted tooth did not respond to the pulp sensibility testing. There was no metallic tone on percussion indicating no ankylosis. Radiographically, progressive obliteration of the root canal was evident in the transplanted tooth. No new resorptive defects were observed on either tooth (Fig 4F).

Discussion

In the present case, the patient was diagnosed with replacement resorption in #8 and inflammatory root resorption in #9. It is interesting to note that the impact trauma induced different types of resorption in these teeth, which could be attributed to a difference in the type and intensity, of the impact and their influence on the periodontal ligament, and the volume of exposed dentinal tubules coronally in #9. The coronal aspect of tooth #9 had a large resin composite restoration which could have attributed to the loss of pulp vitality.

Various levels of success of autotransplantation based on criteria such as pulpal and periodontal healing as well as esthetics and quality of life have been described [13]. In the present case, level 1 complete success occurred in relation to the autotransplanted tooth with tissue healing, restored function and esthetics leading to an improved quality of life. Canines, premolars and third molars are potential donor teeth for autotransplantation but here are differences in their survival rates[13]. Similarly, teeth with immature apices have been reported to have the highest survival rates with fewer post-operative complications[14]. In the present case, the maxillary premolar was favored as the donor tooth based on its stage of root development (Cvek stage3), root dimensions and the volume of bone at the recipient site.

The procedures for surgical removal and placement of the donor tooth in the recipient site influences the extraoral time, damage to the periodontal ligament and its accurate positioning, all of which cumulatively play a pivotal role in the outcome. Production of computer-aided machined donor tooth replicas has been reported to improve survival rates (95.5-100%) as a consequence of the reduced extraoral time [15]. A retrospective cohort study comparing the use of 3D printed donor tooth replicas for autotransplantation reduced the extra oral time to an average of 12 seconds with higher success rates (90%) in comparison to conventional osteotomy procedures without replicas, which averaged 5 minutes [16].

In the present case, complete periapical healing was observed radiographically two years post-operatively but with obliteration of the root canal in the transplanted tooth. Pulp obliteration has been observed in 53% of autotransplanted teeth with factors such as type of splinting, surgical procedure and orthodontic treatment having an influence on the condition of the pulp [17]. Orthodontic treatment has been reported to increase the chance of pulp canal obliteration, however, the evidence that factors such as

splinting and orthodontics influence the condition of the pulp is limited and should be interpreted cautiously [17].

Inflammatory root resorption can be managed by a) arresting the clastic activity with the use of intracanal medicaments and root and canal treatment, b) autotransplantation, c) regenerative endodontic therapy, d) extraction in case of extensive resorption [5, 18, 19]. Use of long-term calcium hydroxide medication requires patient compliance and can affect the mechanical properties of the collagen of root dentin. Use of a tricalcium silicate apical plug in comparison to regenerative endodontics procedure in cases of inflammatory root resorption has shown similar overall outcomes [19]. In the present case, tooth #9 was managed by filling the entire canal with Biodentine, which has the potential to arrest clastic activity as well as aid in periapical healing. At two years, no new resorptive defects had occurred despite subsequent orthodontic force application. Long term comparative clinical studies are needed to provide more evidence to support this clinical strategy.

Czochrowska et al. [20] reported that approximately one-fourth of patients with transplanted premolars reshaped to replace maxillary incisors had unsatisfactory aesthetic results. Hence, during the tooth autotransplantation procedure, it is preferable to quickly restore or reshape the transplanted tooth so that it is aligned with the adjacent anterior teeth. The current case report used CAD-CAM technology to create an interim veneer for the donor tooth using a digital process. This interim veneer provided rapid restoration of appearance and functionality without jeopardizing the integrity of the donor tooth or the healing process [12]. In the present case report, a CAD-CAM PMMA was utilized, which possesses superior mechanical properties in comparison with traditional heat-cured PMMA [21].

Conclusion

This case report highlights the successful interdisciplinary management for replacement resorption using guided autotransplantation of an immature premolar to the #8 region with an immediate satisfactory esthetic outcome. Tooth #9 was root filled with Biodentine.

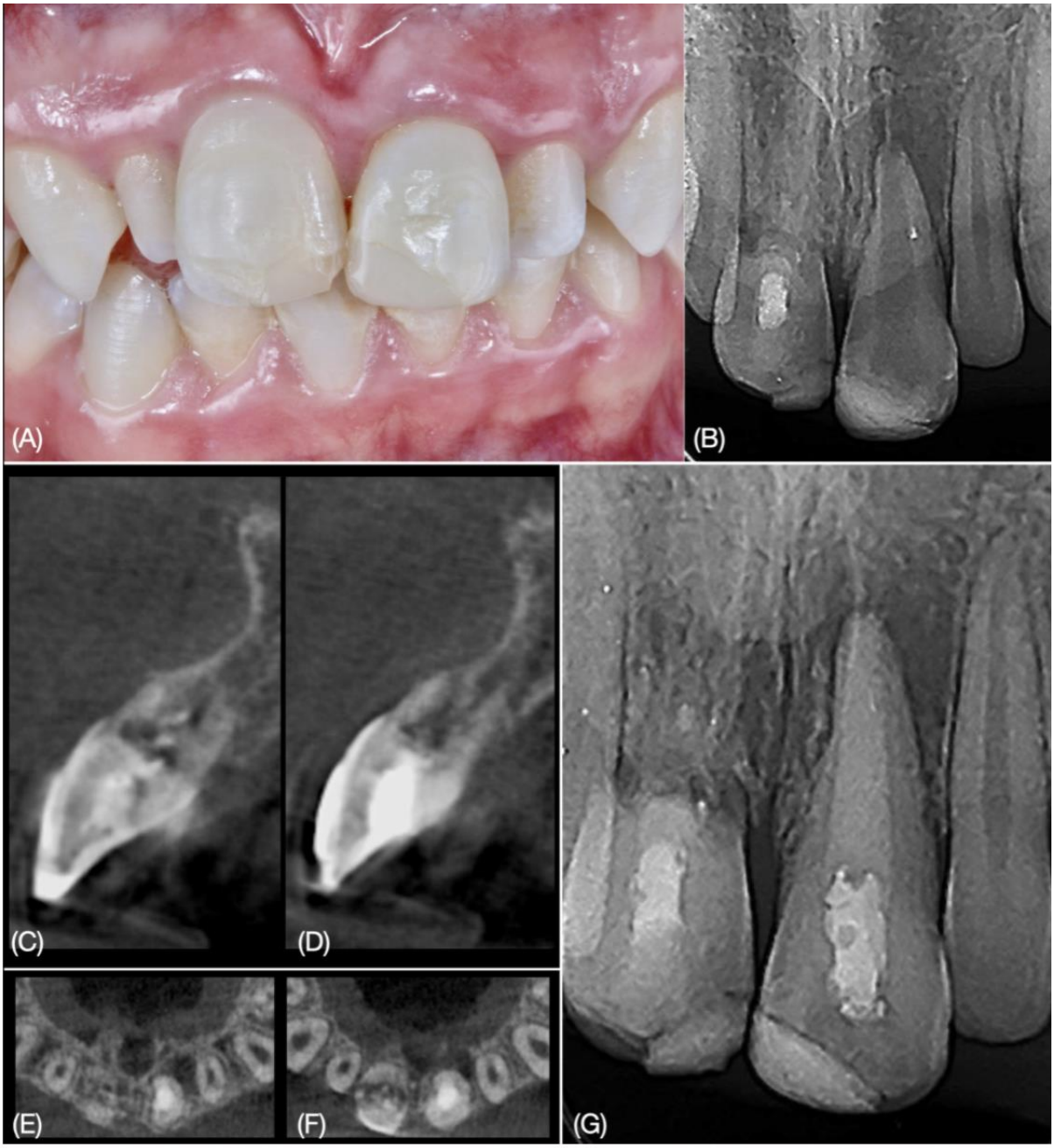

Figure 1. Initial situation 8 months after the avulsion of tooth #8. (A) Substantial infraocclusion of tooth #8 after the delayed replantation. (B) Periapical radiograph revealing external replacement resorption on tooth #8 and external inflammatory resorption on tooth #9. (C, D) Selection of pre-operative cone beam computed tomography (CBCT) sagittal slices. Notice how in tooth #8 the cementum and dentin were resorbed and replaced by bone. (E, F) Selection of pre-operative CBCT axial slices. (G) Root canal treatment of #9 with a Biodentine root filling.

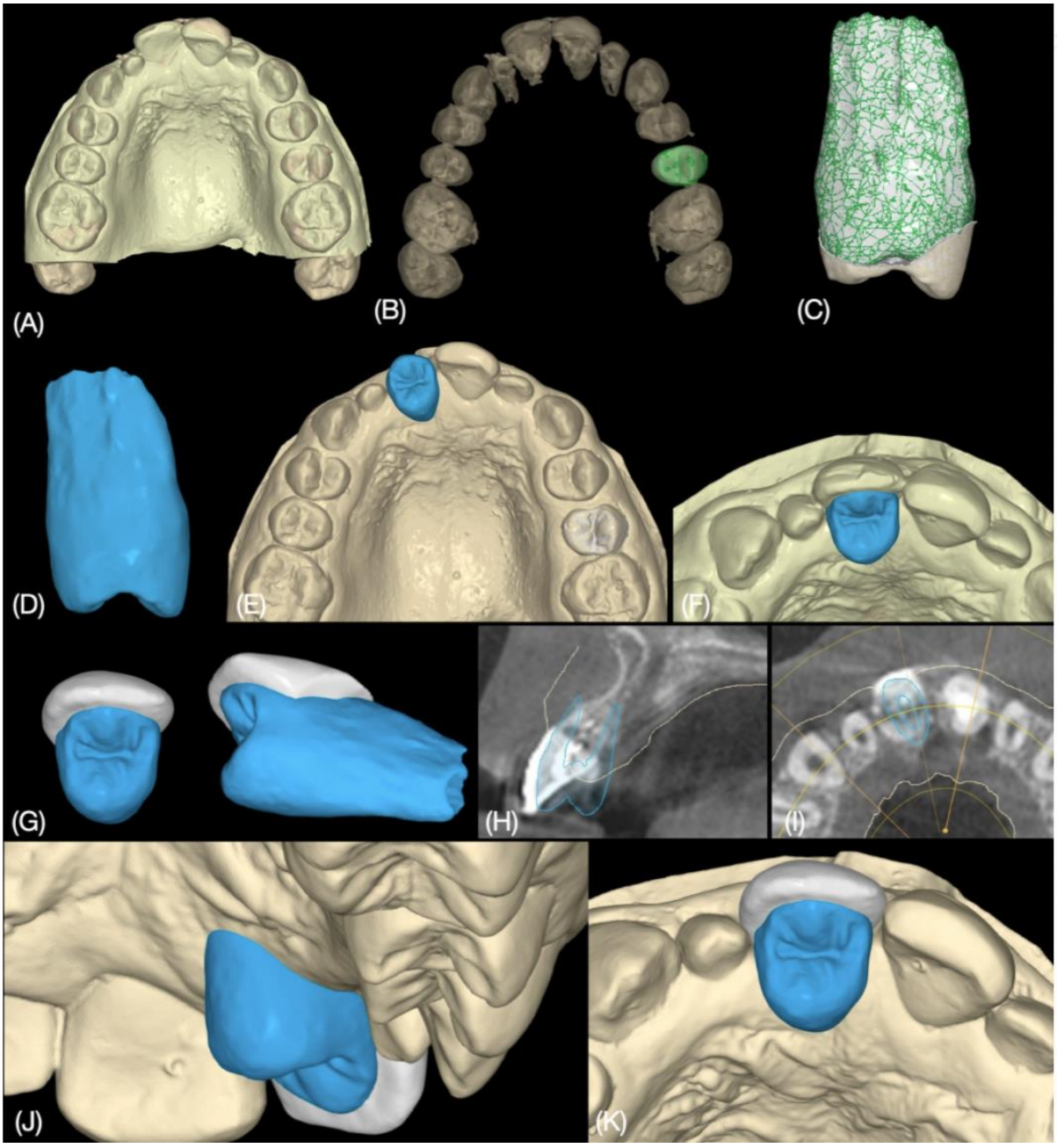

Figure 2. Digital planning of guided autotransplantation using a single-rooted second premolar in the #8 region. (A) Alignment of the preoperative scan of the maxilla (Medit i500, Medit corp., Seongbuk-gu, South Korea) and the CBCT scan. (B-D) Virtual segmentation of tooth #13. (E) Ideal 3D placement of the donor tooth in the recipient socket. (F, G) Design of the veneer on the donor tooth with the precise original shape of tooth #8. (H, I) Verification of the 3D position of the donor tooth in various CBCT slices. (J, K) Images of the donor tooth with the attached veneer in the recipient socket.

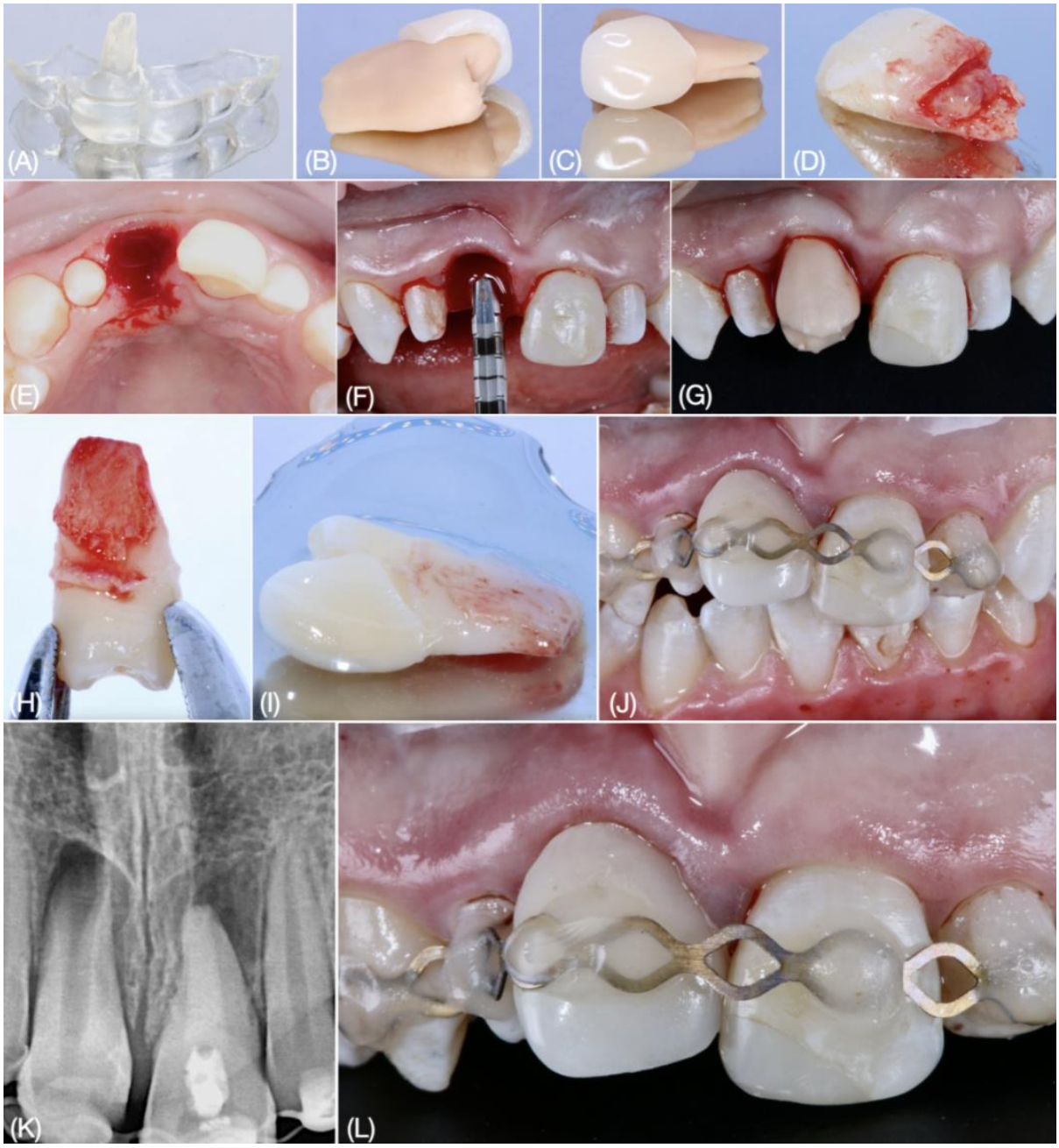

Figure 3. Guided tooth autotransplantation. (A) 3D printing of the donor tooth with guiding template. (B, C) The interim veneer was milled using a PMMA disk. Observe the veneer fit check on the 3D-printed donor tooth. (D) Extraction of tooth #8. (E) Recipient socket after extraction of the resorbed tooth. (F) Minor modification of the recipient socket using an implant bur (Klockner system, Barcelona, Spain). (G) 3D-printed tooth replica in the modified socket. (H) Atraumatic extraction of the donor tooth. (I) Extraoral cementation of the interim veneer. (J) Semi-rigid splinting after tooth autotransplantation. (K) Immediate postoperative periapical radiograph of the transplanted donor tooth. (L) Semi-rigid TTS titanium trauma splint placed for 4 weeks.

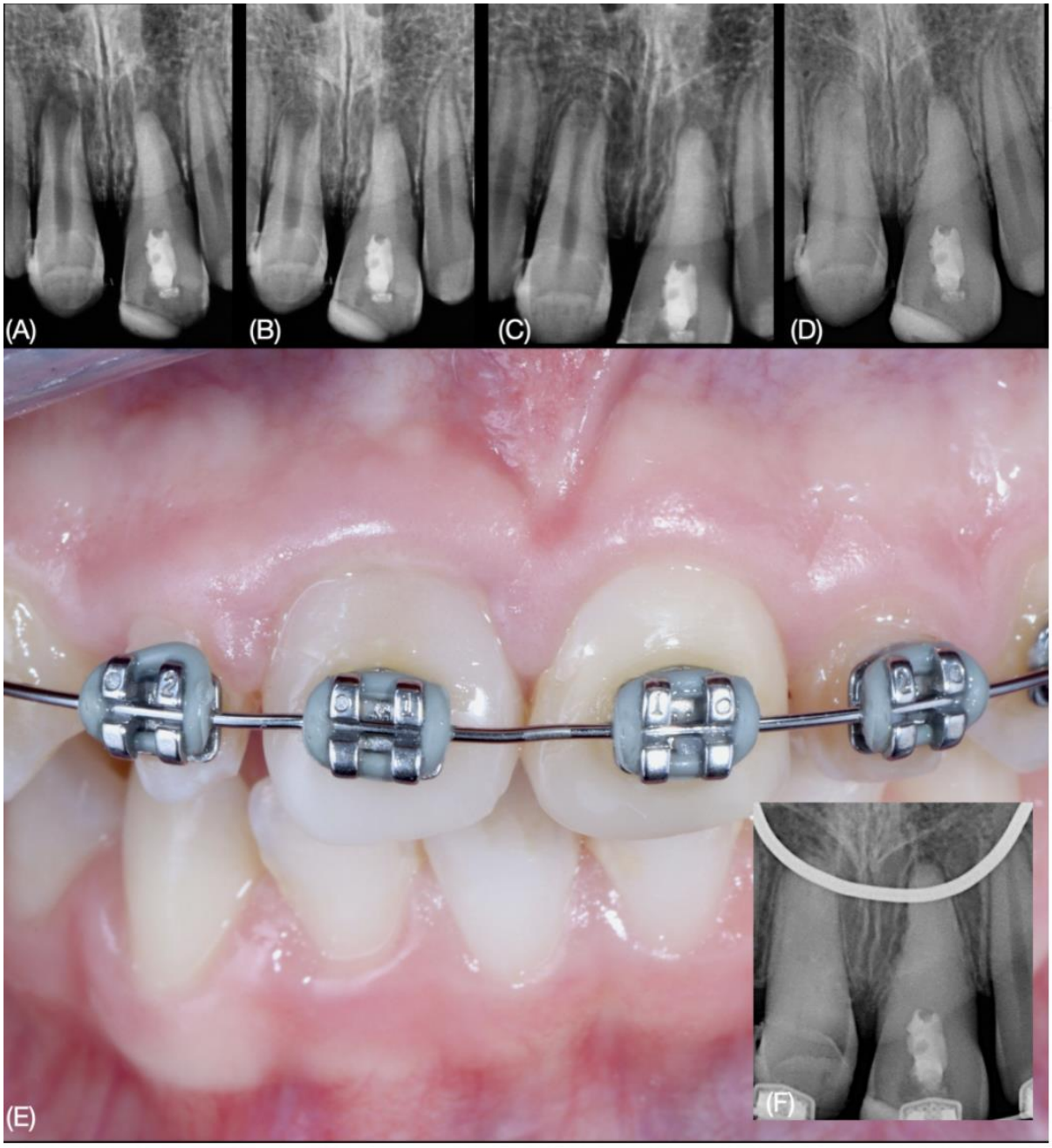

Figure 4: Follow-up peripical radiographs at (A) 1 month, (B) 4 months, (C) 8 months and (D) 12 months. (E) Start of orthodontic treatment. (F) At 24 months there is no evidence of periapical pathosis on either tooth and adequate root-end development of tooth #8 has occurred.

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