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Periodontal Regeneration of Teeth with Radicular Developmental Groove after Intentional Replantation: Two Case Reports

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ABSTRACT

Our case reports probe whether intentional replantation is a feasible and successful treatment for teeth with radicular developmental groove. Radicular developmental groove is an anatomical malformation that often leads to combined periodontal-endodontic lesion. Treatment of complex radicular groove presents a great challenge to the operator. Two cases of periodontal compromised teeth with this developmental anomaly were treated with intentional replantation and followed up for 2 years. The teeth were asymptomatic and functional. The periodontal probing depths decreased from original 10 mm to 2-3 mm. The receded gingival papillae associated with the teeth was regenerated two years after intentional replantation. With careful case selection and treatment planning, intentional replantation may be a predictable alternative treatment modality for the combined endodontic-periodontal lesion accompanied with radicular developmental groove.

Keywords: Gingival Papilla; Intentional Replantation; Radicular Groove

Introduction

Intentional replantation has been defined as the insertion of a tooth into its original alveolar socket after the tooth has been deliberately extracted for performing a quick repair/treatment, such as root-end filling or perforation repair. It is considered to be the last method of choice for preserving the teeth due to the risks involved. It is also believed to be an often overlooked but cost-effective treatment modality [1], as it is a technically sensitive procedure. The survival rate of intentional replantation in reports varies from 82% to 91% [2-5]. A meta-analysis revealed that the overall survival rate, based on periradicular healing and functional success, [6] was 89.1%; while success rate for endodontic treatment (criteria being: no periapical radiolucency present, no external root resorption or ankylosis, no signs/symptoms, and normal probing depths） [4] differed from 72.4% to 94.4% [1]. Most common indications for intentional replantation are when routine root canal treatment is impossible or impractical or has failed [7], or there are anatomic limitations for apical surgery [8]. Contraindications to intentional replantation include: non-restorability of the tooth [9], complicated root morphology such as curved root, tooth fracture during extraction or during the replantation [8], and patient's medical history that prevents surgery or extraction [7]. Traditionally, a periodontal compromised tooth has been thought to be a contraindication for intentional replantation [10]. However, a recent study pointed out periodontal involvement was not an absolute contraindication to intentional replantation. Teeth with one preoperative periodontal pocket ≥6 mm showed 84% cumulative improved rates, which defined as a decrease in the number and depths of periodontal pockets and the size of periapical radiolucency and no external root resorption or sign/symptoms [11]. Often they are easier to extract as well.

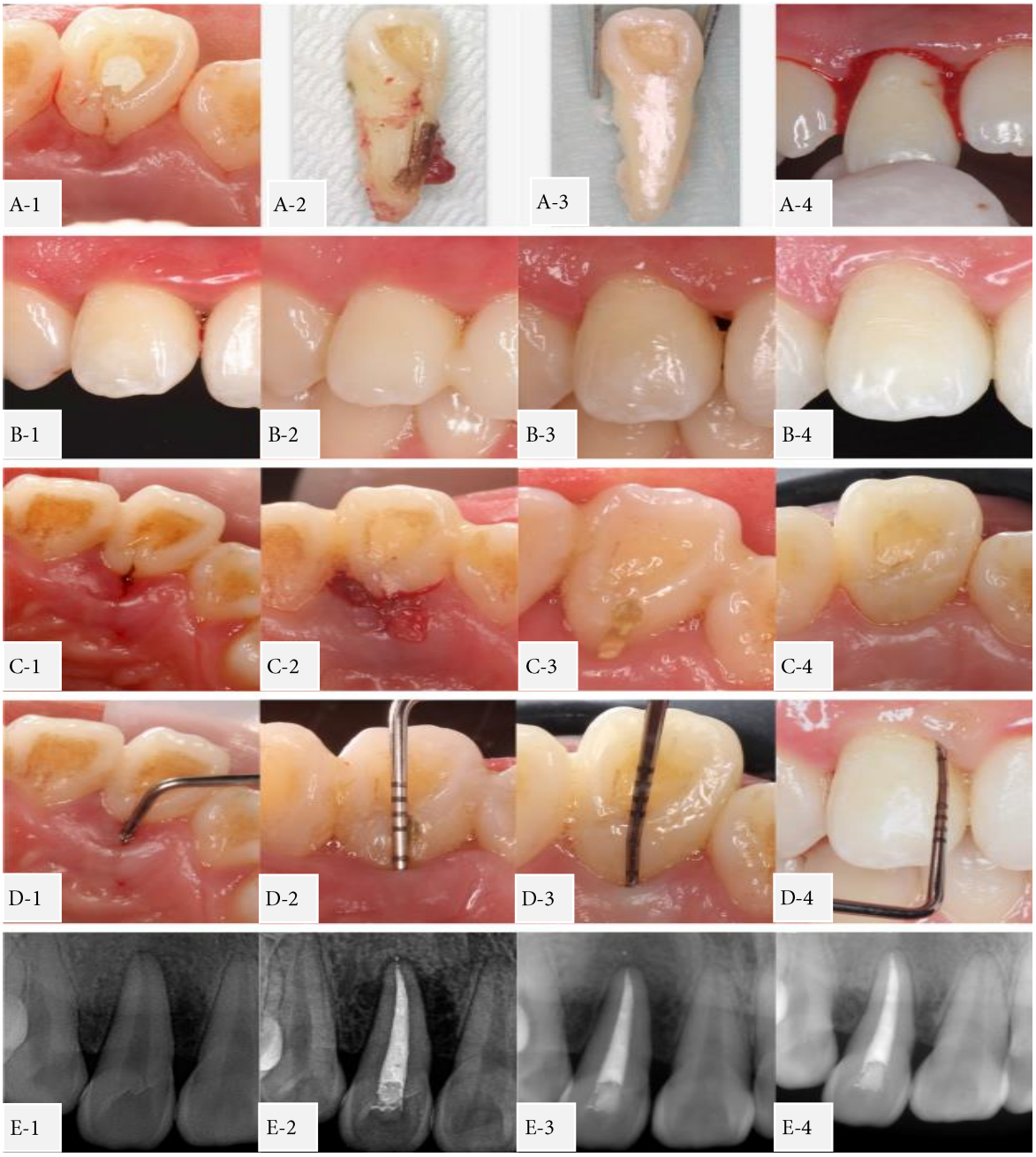

Figure 1 *A-1*) Coronal photographic view of lateral incisor after root canal therapy; *A-2)* Upper lateral incisor after extraction; a deep palatal radicular groove was found up to 1/3 of the apex, with deposit of dental calculus and granulation tissue in and around the groove after extracting; *A-3)* IRoot BP Plus was applied to seal the whole groove after cleanup; *A-4*) The tooth was replanted back to the socket; *B-1*) Labial view of the gingival papilla at the initial visit; *B-2)* Appearance of gingival papilla two weeks post intentional replantation (IR); *B-3*) The interproximal papilla receded with a marked black triangle 6-month after IR; *B-4*) Labial view showing gingival papilla has completely filled the inter-proximal embrasure 2-year after intentional implantation; *C-1*) The gingival papilla appearance was red and swollen on palatally on the first visit; *C-2*) Palatal view of the gingival papilla immediate post-operation; *C-3*) Two weeks post IR, the color and texture of palatal periodontal tissues recovered to stippled pink; *C-4*) Palatally, the gingival papilla completely filled the inter-proximal embrasure 2-years after intentional implantation; *D-1)* The probing depth was 10 mm palatally before surgical operation; *D-2*) The probing depth was 4 mm at palatal site 6-month after IR; *D-3)* Two years after intentional implantation, probing depth was 2 mm in the palatal gingivae; *D-4*) Labial at two years post op, probing depth was 2 mm ; *E-1*) Periapical radiograph shows decreased alveolar bone density mesial of the lateral incisor in the initial visit; *E-2*) The radiographic evaluation of tooth after root canal treatment; *E-3)* The radiographic evaluation of tooth showed increased bone density 6-month post operatively; *E-4*) No ankylosis or external root resorption of the tooth was found in the final periapical radiograph 2-year after IR

We found several success stories with intentional replantation of teeth with radicular grooves [12-15]; however, their follow up outcomes and changes in the gingival recession after intentional replantation were not reported. Previous studies did not report whether the compromised interproximal papilla had recovered after replantation, though it is a critical esthetic criterion for periodontal recovery. This article reported two clinical applications of intentional replantation in teeth with combined endodontic and periodontal lesions caused by radicular developmental groove and followed them for two years.

Case Reports

Case 1

A 19-year-old Asian female complained of recurrent pain, pus discharge and swelling from her right anterior palate, with an approximate two year history. She had completed orthodontic treatment 4 years earlier, but had noticed that her lateral incisor shifted labial gradually since then. She had also received full mouth scaling and root planing 2 years earlier. Her medical history and extra-oral exam were unremarkable. Intra-oral examination showed the maxillary right lateral incisor was slightly labially inclined with a minor receded gingival papilla (Figure 1B). A swelling associated with the palatal gingival sulcus of her upper right lateral incisor was visible and a palatal groove was found to extend to the root surface subgingivally (Figure 1C). A deep 10 mm pocket of was detected on the palatal site (Figure 1D) with bleeding on probing, while probing depths on mesiobuccal, buccal, distobuccal, distopalatal and mesiopalatal were all 2 mm. The tooth was sensitive to palpation and percussion. Mobility was within physiological limit. Lingering pain was detected on thermal test compared to unaffected/normal teeth. Radiographs showed decreased alveolar bone density on the mesial site of lateral incisor (Figure1 E-1). Diagnosis of irreversible pulpitis, symptomatic apical periodontitis and combined periodontal-endodontic lesion were established. Treatment options included: insertion of implants after tooth extraction or endodontic treatment followed by (a) periodontal flap surgery and (b) intentional replantation (IR). It is extremely challenging to remove the affected tissues along the deep developmental groove and then eliminate the groove by flap surgery. With careful risk *versus* benefits evaluation, and full consultation with the patient, the patient preferred the endodontic treatment with IR and signed an informed consent form.

Initially, root canal therapy was performed under rubber dam isolation. The length of canals achieved with radiography and they were prepared with NiTi Instruments (Waveone Gold, Dentsply Sirona, Tulsa, OK, USA) according to manufacturer's instruction and intermittently irrigated with 20 mL of 1% NaOCl. Canals were dried and filled with gutta-percha using warm vertical technique (Figures 1 A, E-2). One week after root canal therapy, IR was carried out. The tooth was extracted by minimally invasive elevator (Type: L-1S, Directa, Upplands Väsby, Sweden) and inspected extra-orally. The deep palatal radicular groove was found to extend to the apical 1/3 of the apex, with deposit of dental calculus in and around the groove (Figure1 A-2). The dark calculus was curetted with a combination of ultrasonic scaler and a small round bur in a high-speed hand piece with water spray until the surface of groove was clean. iRoot BP Plus (BP-RRM; Innovative BioCeramix Inc, Vancouver, Canada) was applied to seal the whole groove (Figure1 A-3). The tooth was kept moistened by using a gauze saturated with saline during the whole procedure and the total extra-oral operation time was about 10 min. The tooth was then replanted (Figure1 A-4) and splinted with the adjacent teeth using flowable resin. The gingival papilla completely filled the inter-proximal embrasure immediately post-operation (Figure1 C-2). The patient reported only a slight post-operative pain on the operation day and did not report any discomfort from the second day onwards. Two weeks after replantation, the color and texture of periodontal tissues had recovered to healthy texture (Figure1 B-2, C-3), and the splint was removed. Six months later, the probing depth was 4 mm on the palatal site (Figure1 D-2), and the interproximal papilla receded with a marked black triangle (Figure1 B-3). Radiographs revealed increased bone density and establishment of normal periodontal ligament space (Figure1 E-3). Composite resin was used to replace the iRoot BP that was exposed supra-gingivally at this visit since the patient did not come back until six months later. In the two year post-operative follow up, the patient was still asymptomatic. The probing depth was reduced to 2 mm (Figure1 D-3, D-4) and the gingival papilla completely filled the inter-proximal embrasure (Figure1 B-4, C-4). There was no sign of ankylosis or external root resorption at the final x-ray examination (Figure1 E-4).

Case 2

A 29-year-old Asian man was referred to Endodontic Department of Stomatological Hospital, Southern Medical University, Guangzhou, Guangdong, China. He complained of intermittent slight pain when he chewed on his lower right area; this discomfort had been presented for the past 5 years. His medical history was unremarkable. According to his dental records at the first visit, a wedge-shaped defect with painless pulp exposure was detected in the mesio-cervical part of mandibular right first premolar. Intra-oral examination showed a temporary filling material was placed in the cervical defect.

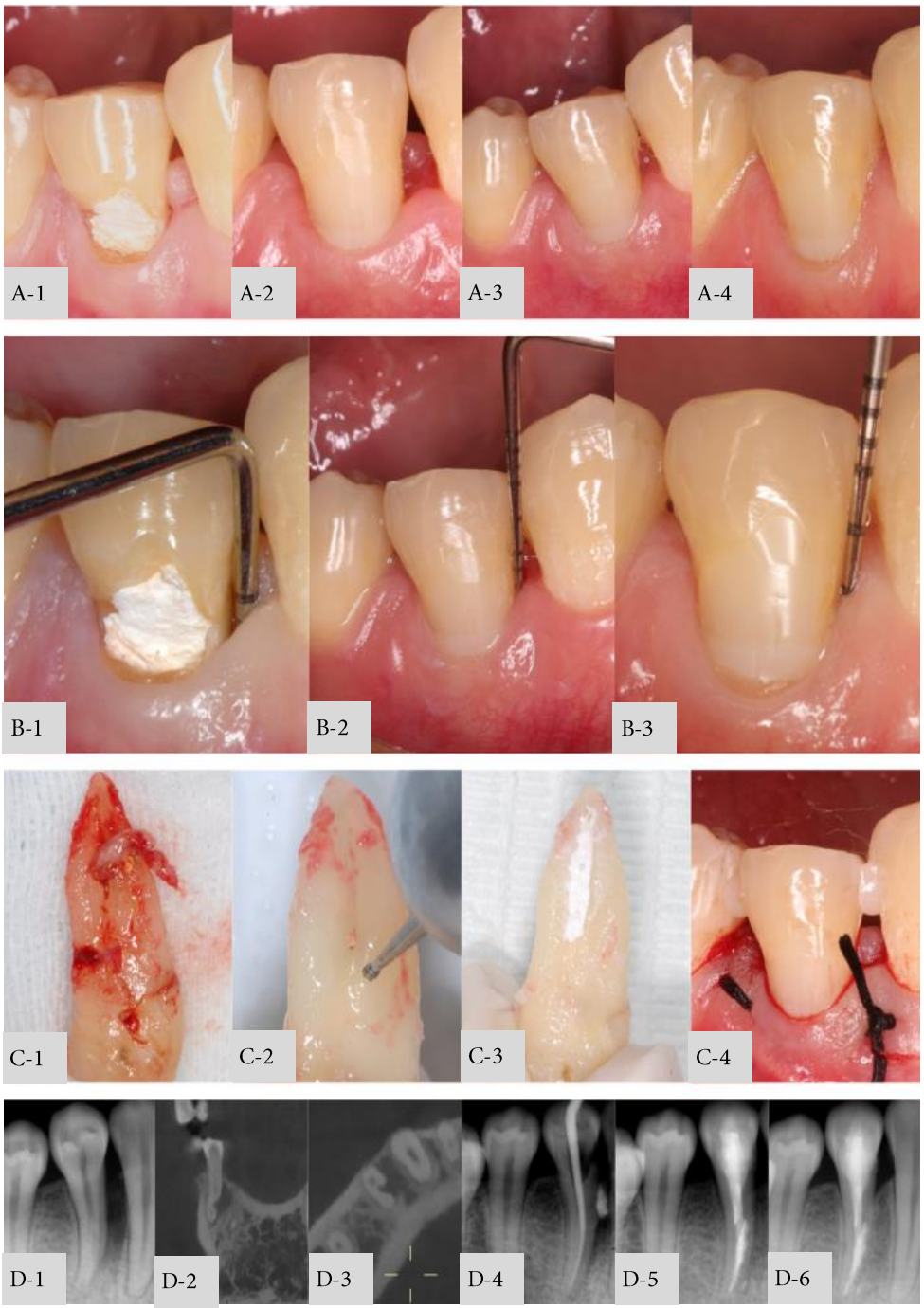

Figure 2 *A-1)* Photographic labial view of #28 gingival papilla before operation; *A-2)* The gingival papilla 1-month after intentional replantation (IR); *A-3)* The labial gingival papilla appearance 4-month after IR; *A-4)* Gingival papilla 2-year post-IR; *B-1*) The probing depth on the labial/mesial side of first premolar was 10mm before operation; *B-2*) The probing depth on the mesial side decreased to 2-3 mm 4-month post op; *B-3*) The probing depth on the mesial side of #28 was maintained (3 mm) 24-month post IR; *C-1*) Granulomatous tissue was seen adhering to the developmental groove after the tooth was extracted by minimally invasive surgery; *C-2*) The exposure of gutta-percha and dental calculus was detected in the groove after removal of granulomatous tissue on the mesial side of #28; *C-3*) IRoot BP Plus was applied to seal the groove of #28; *C-4*) The gingiva of #28 was sutured and the tooth was splinted with adjacent teeth with flowable resin; *D-1)* The radiographic evaluation of #28 showed decreased alveolar bone density along the mesial side before operation; *D-2)* A developmental radicular groove in the mesial site of root surface on vertical plane; *D-3)* A developmental radicular groove in the mesial site of root surface was found on horizontal plane; *D-4)* Calcium hydroxide spillage into the mesial periodontal tissue while placing the master cone ; *D-5)* The radiograph showed enhanced alveolar bone density along the mesial site of #28 4-month after IR; *D-6)* Periapical radiograph showing total recovery of lesion around the tooth 24-month after IR

(Figure2 A-1). Our patient displayed slight discomfort on percussion and palpation of the premolar. Cold test (Friljet Spray, Merignacm, France) and electrical pulp test(Skylun, Guangdong, China) were negative in comparison with the contralateral tooth which demonstrated a positive response. Tooth mobility test was grade 1. A slightly receded papilla (Figure2 A-1) and a probing depth of 10 mm were detected on the mesial side of tooth #28 (Figure2 B-1). His former radiographs showed decreased alveolar bone density along the mesial side of tooth #28 (Figure2 D-1). Cone-beam computed tomography (CBCT) was applied due to root canal morphological irregularity. The C-shaped configuration in the cross sections of teeth (Figure2 D-3) indicated that there was a developmental radicular groove in the mesial site of root surface (Figure2 D-2). A preliminary diagnosis of pulp necrosis, symptomatic apical periodontitis was reached. Since no direct communication between the developmental groove and the root canal was observed on the CBCT, the initial treatment plan was combined with non-surgical endodontic and periodontal treatments. Informed consent was signed after explaining the options and prognosis to the patient. Following access of tooth #28, one root canal was located and instrumented with WaveOne Gold Primary (Dentsply Sirona, Tulsa, OK, USA); and irrigated as previous case. It was disinfected with intracanal medicament calcium hydroxide for one week. At the following visit, the master cone (taper 0.04, 25) radiograph showed that calcium hydroxide had spilled into the mesial periodontal tissue (Figure2 D-4), indicating the presence of a communication between root canal and periodontal tissue shifting the ultimate diagnosis to combined perio-endodontic lesion.

Due to the mandibular anatomical limits for endodontic surgery, further treatment options including intentional replantation post-endodontics or tooth extraction were discussed with the patient. After risks *versus* benefits were discussed, the patient chose intentional replantation to save the tooth. The apical part of root canal was obturated with warm gutta-percha (Meta Biomed Co., Cheongju City, Korea) and coronal part was initially restored and sealed with fiber post and cement (RTD, St Egreve, France), according to manufacturer's instructions. Coronal restoration was completed with prime, bond and composite resin (3M ESPE Adper, St. Paul, MN, USA) strictly adhering to manufacturer's instructions. The insertion of fiber post into the coronal part of root canal was to avoid the cervical fracture during the extraction. IR was carried out immediately after coronal restoration. Once the tooth was extracted by minimally invasive surgery, granulomatous tissue was found to adhere to the developmental grooves (Figure2 C-1). The exposure of gutta-percha and dental calculus were detected in the groove after removal of granulomatous tissue (Figure2 C-2). iRoot BP Plus was applied to seal the groove (Figure2 C-3). After irrigation of alveolar socket with saline, the tooth was gently replanted and the gingivae were sutured. Flowable resin (3M ESPE Adper, St. Paul, MN, USA) was used to splint the surgical tooth with the adjacent teeth (Figure2 C-4). The total extra-oral time was between 9-10 min, and the tooth was kept moist during the whole procedure. One week later, the patient reported minimal pain one day post-surgery. After removal of suture and splint, the tooth mobility was grade 2. The patient was asymptomatic at one-month follow-up. The tooth mobility had recovered to grade 1, and the interproximal gingival papilla was found to recede 1-2 mm at the one week visit (Figure2 A-2). At four months, the patient reported the tooth was functional without any symptom. The tooth mobility was in physiological limit and the probing depth decreased to 2 to 3mm (Figure2 B-2). The gingival papilla had recovered to baseline level (Figure2 A-3). The radiography showed enhanced alveolar bone density along the mesial site of tooth #28 (Figure2 D-5).

At 2-year follow-up, the full gingival papilla filled the interproximal embrasure and probing depth was maintained at 3 mm (Figure2 A-4, B-3). Radiographic evaluation showed total recovery of the lesion approximate to the tooth (Figure2 D-6).

Discussion

Palatal grooves in the roots are developmental in origin, usually found on the lingual side of maxillary incisor teeth [16]. It is commonly found in the permanent maxillary lateral incisors, with variable occurrence rates ranging from 4.4% to 18% [17, 18]. Clinically, they often contribute to isolated deep periodontal pocketing due to loss of attachment in that area. The groove could be deep enough to communicate with the pulp, causing bacterial invasion and pulpal infection. The combination of nonsurgical endodontic and periodontal regenerative treatment is a predictable method in treating combined endodontic-periodontal lesions caused by palato-gingival groove in some cases [19, 20]. Besides, intentional replantation is recommended for teeth with medium to deep palatal grooves with communication to a root canal system [14, 21], despite their technical difficulty. In our first case, though direct communications were not detected between root canal and periodontal tissue, irreversible pulpitis was still thought to be of periodontal origin, because bacteria and endotoxin could penetrate through the thin layer of dentin

between the pulp and the palatal groove. It is extremely challenging to clean the dental calculus thoroughly in and along the groove, and seal the groove with bioceramic material by flap surgery. In addition, patient may suffer from severe gum swelling and discomfort postoperatively with periodontal flap surgery. When we look at the advantages and disadvantages of treatment options including tooth extraction, periodontal flap surgery and intentional replantation following endodontic treatment, both patient (and clinician) were included towards IR [22, 23].

The incidence of mandibular first premolars with developmental grooves is thought to be 14% [24]. About 95.7% radicular grooves are often located in the mesial side of mandibular first premolar, with depth ranging from 0.75 to 1.13 mm [24]. Although radicular grooves in mandibular first premolars were usually associated with several anatomical variations, they seldom caused initial periodontal destruction because these developmental grooves were located 3.10±1.45 mm (in average) below the cementoenamel junction [24]. If we take this into account, our second case was likely a primary endodontic lesion with secondary periodontal involvement.

Accumulation of the dental calculus and plaque in the radicular developmental groove was caused by long-term untreated endodontic lesion through groove perforation, leading to destruction of the peri-radicular alveolar bone and persistent inflammatory drainage through the gingival sulcus. We thought the second case was too risky for surgical periodontal management, because the pathological area located on the mesial side of the tooth root of #28, is too close to the adjacent healthy tooth. Therefore, we preferred IR following the endodontic treatment instead of endodontic surgery.

Patients in both cases felt minimal pain the day after surgery and no further discomfort at follow-ups. The probing depth of periodontal tissue and tooth mobility had returned to normal values without pathological root resorption or tooth ankylosis. Though we noticed receded dental papilla baseline and gingival black triangle, which were more pronounced after intentional replantation, the dental papilla regenerated and completely filled the interproximal embrasure 2 years later. Possible factors contributing to this good outcome include: (1) the resorbed bone had recovered to the original level with the resolution of endodontic and periodontal infection; (2) re-establishment of biological width and gingival creeping attachment of dental papilla after surgery; (3) both patients' maintained good oral hygiene as we had instructed.

Both our two clinical cases were combined endodontic/periodontal lesion presenting with deep periodontal pockets; the radicular developmental grooves were the anatomic contributing factors for the infection. Thorough removal of infection and effective sealing of the developmental groove were the two keys to long term success. The radicular developmental grooves in both cases were filled with iRoot BP Plus, which is a pre-mixed calcium silicate-based bioceramic putty [25], developed for perforation repair and root end filling. This material was hard compacted into the developmental groove in the first case and showed resistance to wash-out in the cervical area. We are as yet ignorant of the exact biological adhesion mechanism in the interface of iRoot BP Plus and periodontal tissue. Some studies have shown that iRoot BP Plus was osteoconductive [26, 27]. Many *in vitro* studies showed obvious apatite-forming ability of this material in simulated body fluid [25]. The periodontal probing depths in both cases decreased from original 10 mm to 2.5-3 mm, indicating excellent sealing, adhesion, and biocompatibility of this bioceramic material.

Atraumatic speedy technique in IR is absolutely crucial so as to maintain the vitality of the periodontal ligament and avoid desiccation. Elevators are often discouraged for luxation of the tooth and this minimizes the trauma to alveolar bone during the tooth extraction [15]. Placing preoperative orthodontics to extrude or move the tooth and facilitate atraumatic extraction can achieve better results [6]. Extra-oral operation time less than 15 min was also critical to maintain the vitality of the PDL cells [5]. Therefore, this form of treatment can only be successful in the right experienced hands.

The shortcoming of our two case reports included: (1) pre-operation CBCT examination was not applied in the first case, and it was not possible to confirm whether there was communication between the developmental groove and the root canal; (2) two case reports are not sufficient to observe the effect and the feasibility of intentional replantation as a conventional treatment and to draw conclusive recommendations. We would recommend further clinical studies in this field.

Conclusions

With the careful case selection and treatment planning, intentional replantation could be a predictable alternative treatment modality for the combined endodontic-periodontal lesion with radicular developmental groove. Resorbed bone and receded gingival papillae were regenerated two years after operation, showing good aesthetic results in our two cases.

Conflict of Interest: 'None declared'.

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