Root Canal Filling after Revascularization/Revitalization

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Introduction: *Revascularization/revitalization therapy is considered an alternative procedure for management of teeth with an immature apex and necrotic pulp, mainly when root development is interrupted in the early phases of formation. However, this clinical treatment protocol should be considered a permanent procedure?* ***Method:*** *A maxillary central incisor with a previous and successful RR treatment was intentionally filled with a biocompatible material with the periapical tissues due to the patient's lack of adherence to the follow-up protocol.* ***Results***: *The 20-month follow-up showed absence of clinical, radiological and tomographic signs and symptoms of an endodontic re-infection.* ***Conclusion:*** *This case demonstrates that once the increased thickening of the canal walls, incrementing the root length, apical closure and the total resolution of the apical lesion are observed, the main canal of a previously treated tooth with an RR procedure can be filled.*

Key words: *Immature permanent tooth; mineral trioxide aggregate; revascularization/revitalization, root canal filling*

INTRODUCTION

Since Iwaya *et al.* (2001)[1] resumed the use of the revascularization/revitalization technique (RR) previously proposed by Nygaard-Østby (1961)[2], it has been considered an alternative of treatment for the management of immature teeth with necrotic pulp. The RR procedure has several benefits, such as the resolution of apical lesions, increasing the thickness of the radicular walls, incrementing the root length, apical closure and in some cases, re-established nociception[3].

Nonetheless, the application of this technique was reopened based on a single clinical case. As of yet, there is no clinical universal protocol and its treatment sequence has been modified over time[4]. In fact, its strongest scientific evidence is based on clinical results, as there is a lack of evidence from top-level studies (controlled clinical trials) that will help to establish an ideal therapeutic sequence[5, 6]. Have been reported in animal[7, 8] and human studies[9, 10], that a mix of bone and cement comprised the tissue deposited in the pulpal space after RR procedure. However, Nygaard-Østby (1961)[2] showed that the new hard tissue did not filled completely the root canal system in all the cases. The blood clot gradually is replaced with granulation tissue and then with fibrous connective tissue. Subsequently, after 10 months variable degrees of resorption in the internal dentinal walls were observed. Therefore, in the absence of well conducted long-term studies the RR technique raises several questions, among which is whether the technique serves as a permanent treatment or whether filling of the canal space is recommended. The aim of this case report is to present the intentional filling of the root canal of a maxillary central incisor with a previous and successful RR treatment.

CASE REPORT

An 8-year-old male patient was referred to the Endodontic Department of the University of Guadalajara, Mexico with an 11-month history of complicated crown fracture on tooth #21 (left maxillary central incisor). On the day of the traumatism, a general dentist extirpated the pulp of the affected tooth and placed temporary cement. The medical history was negative for any history of systemic conditions or allergies.

Upon clinical examination, pain to palpation of the oral mucosa was negative, but a buccal sinus tract was detected (Fig. 1A). The dental crown had an extensive coronal fracture and poorly adjusted

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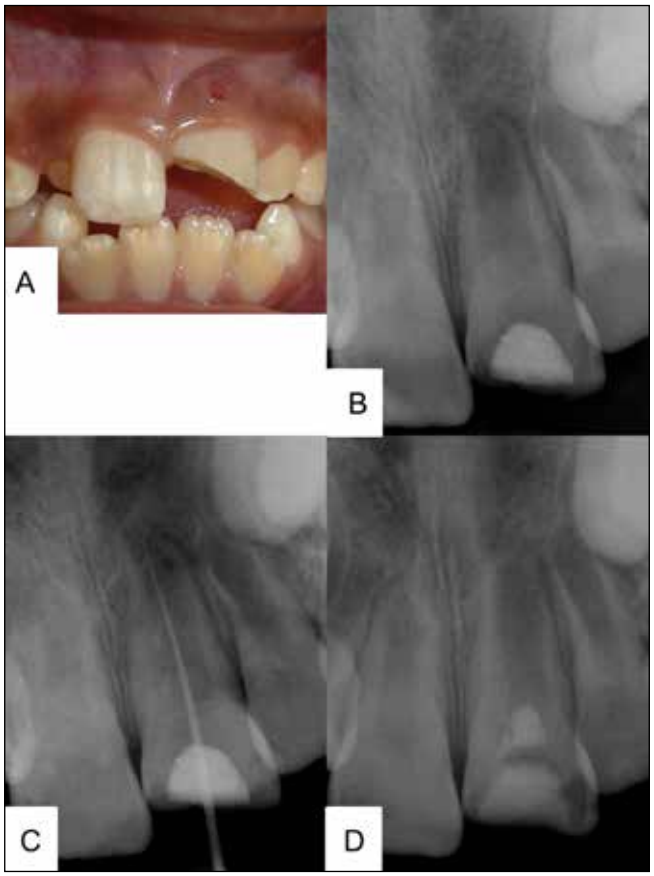
temporary cement. Thermal and electric tests (Digitest; Parkell, Farmingdale, NY, USA) were negative in contrast with the normal response of the neighboring teeth. Depth on probing and mobility were within normal limits. The radiographs showed a wide root canal with thin radicular walls and an apex wider than the canal lumen, along with a diffuse radiolucent periapical lesion (Fig. 1B). The sinus tract radiograph confirmed the tooth #21 as the cause of infection (Fig. 1C). Furthermore, after gathering all clinical and radiological findings, a pulpal diagnosis was established of previously initiated endodontic treatment with signs of infection and a periapical diagnosis of suppurative apical periodontitis. The parents of the patient were given the following treatment options: creation of an apical barrier with MTA, extraction and a RR procedure. The latter option was recommended and chosen for this case, mainly based on the immature stage of root development of the affected tooth.

Revascularization/revitalization procedure

Once the parents of the patient signed the written informed consent, anesthetic infiltration and rubber dam isolation were performed, followed by conventional access to the pulp chamber. The totality of the treatment was performed using dental operating microscope. After the root canal was identified and the non-vitality of the dental pulp was confirmed, the operatory field was disinfected with gauze soaked in 5.25% sodium hypochlorite (NaOCl, Clorox). The working length was determined with a radiograph, and the bacterial biofilm from the internal walls of the main canal was removed mechanically with light instrumentation with manual K-files (Dentsply Maillefer, Ballaigues, Switzerland) and irrigation of 20 mL of 1% NaOCl. To reduce the bacterial load, creamy paste of calcium hydroxide was placed inside the root canal and covered with temporary cement.

Fig. 1. *(A)* **Intraoral front view of the patient in occlusion.** *(B)* **Pre-operative radiograph.** *(C)***. Sinus tract radiograph.** *(D)* **Post-operative radiograph of the RR procedure.**



After 14 days, the patient was symptom-free, and the sinus tract was absent. The operatory field was isolated, followed by infiltration of anesthesia without vasoconstrictors and the temporary sealing material was removed. The intra-canal dressing was eliminated by irrigating with 10 mL of 1% NaOCl and cleaning with small size K-file. Once drying the root canal, bleeding of the periapical tissues was induced. Once a blood clot was formed, 4 mm of white MTA (ProRoot MTA; Dentsply Tulsa Dental, Tulsa, OK) was adapted to its surface in the cervical third, which was previously activated according to manufacturer indications. The access cavity was sealed immediately with glass ionomer cement (Fuji IX; GC Corporation, Tokyo, Japan), its final radiological status was verified (Fig. 1D) and indications of 250 mg of paracetamol were given if necessary. Emphasis was made on the importance of clinical and radiographic follow-up of the case.

Unfortunately, the patient missed the 1- and 3-month follow-up appointments. The first register was made after 4 months. The patient showed no signs or symptoms of infection but still lacked definitive reconstruction (Fig. 2A). Again, emphasis was made on the relevance of case follow-up. However, the patient missed his follow-up appointments and returned after 32 months due to a gradual darkening of the tooth. On clinical examination, the oral mucosa was normal, the dental crown had a definitive composite restoration, and the slight change in coloration of the remaining dental structure was confirmed (Fig. 2B). Palpation and percussion sensitivity were negative. The tooth had a delayed positive response to thermal and electric tests (Digitest; Parkell, USA). The parameters of depth on probing and mobility were normal. Radiographic examination revealed the deposition of a barrier of new hard tissue in the root canal between the MTA cervical barrier and the root apex, a notable increase in the thickening of the radicular walls, an incrementing in the root length comparable to the contralateral central incisor and reduction of the periapical radiolucency (Fig. 2C). Such radiographic changes correspond to type I healing, according to Chen *et al*[11].

Filling of the pulpal space

Due to the patient's lack of adherence to the follow-up protocol, we considered that there was a high probability of re-developing an endodontic infection due to coronal filtration of saliva, and that such infection would be untreatable with a conventional endodontic treatment if the canal system was obliterated; thus, treatment was performed on the main canal.

After a new informed consent was obtained, anesthesia was applied adequately, rubber dam isolation was adapted and the pulp chamber was accessed conventionally. To improve internal inspection of the root, all procedures were performed using dental operating microscope. Once the working area was disinfected, with combined use of 0.5% NaOCl irrigation, DG-16 endodontic explorer and a size #25 K-file, the internal anatomy of the root canal was explored to locate connections with the periapical tissues (Fig. 3A). A new barrier of hard tissue had formed in the middle third

Fig. 2. *(A)* **A 4-month follow-up radiograph. The 32-month follow-up showed** *(B)* **slight change in color in the remaining dental structure of tooth #21 and** *(C)* **Chen's type I radiographic healing (12).**

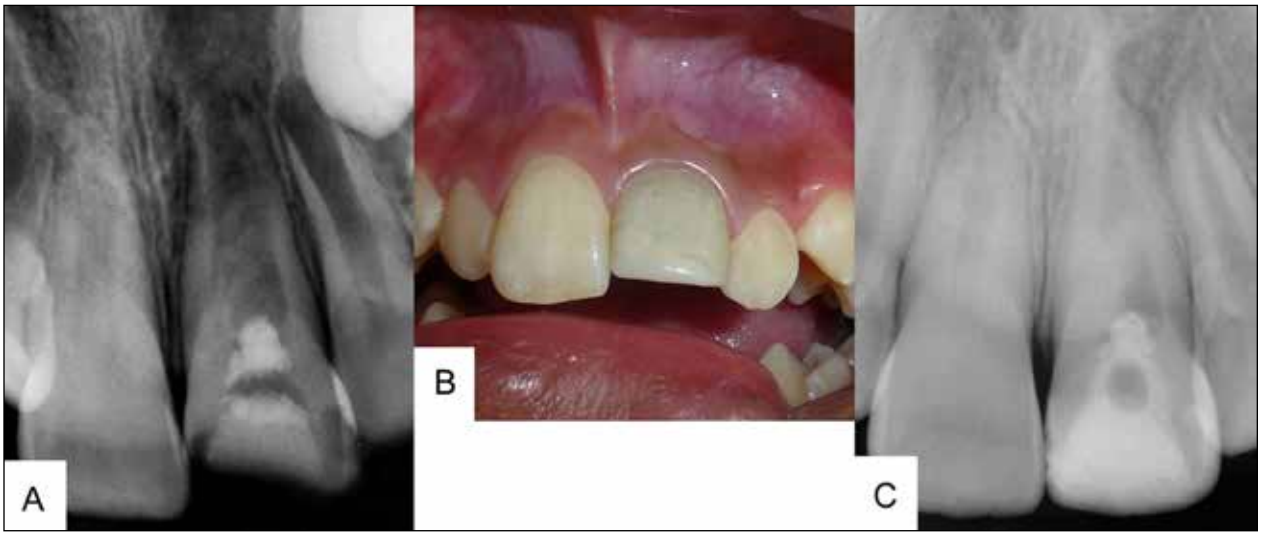
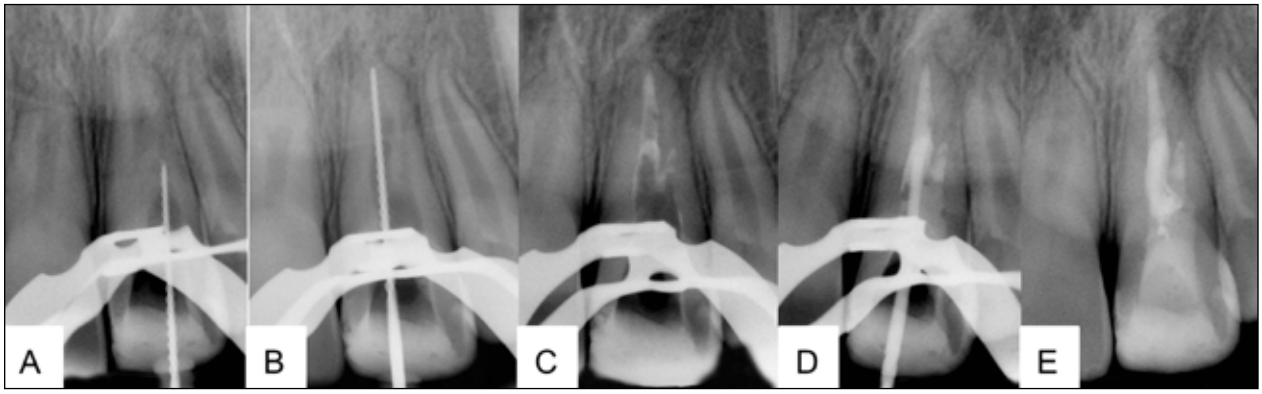


Fig. 3. Radiographic sequence of the filling of the pulpal space. *(A)* **Radiographic examination of the root canal.** *(B)* **Radiographic determination of the working length.** *(C)* **Radiographic verification of the MTA intra-canal compaction.** *(D)* **Radiographic examination of the gutta-percha cone in direct contact with the apical MTA.** *(E)* **Final radiograph.**



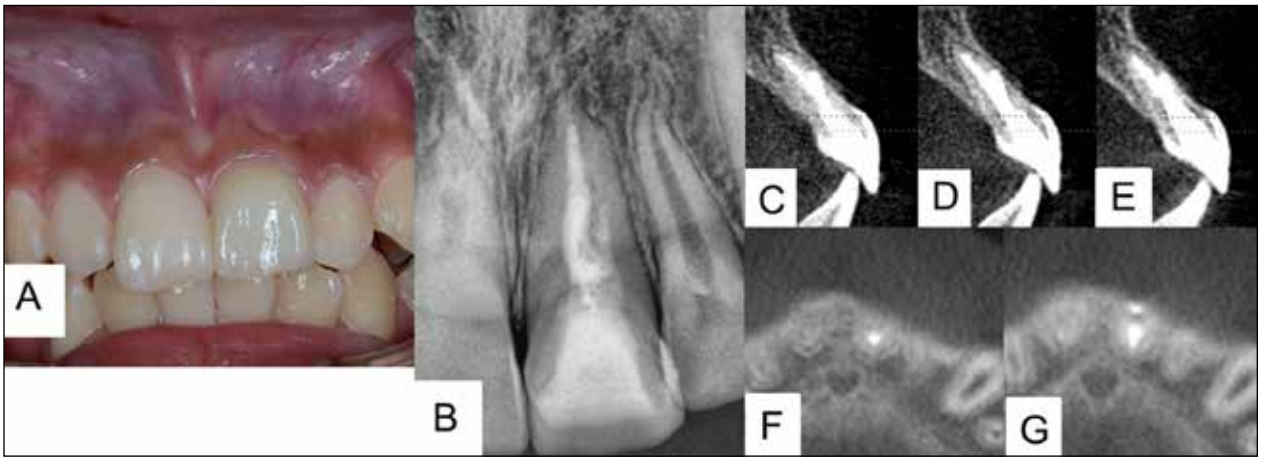
of the root, with a rigid consistency and no true connection with the periapical tissues, which followed a disto-buccal direction. This barrier was carefully perforated with ultrasound tips (START-X Tip #3; Dentsply Maillefer, Ballaigues, Switzerland) and copious irrigation. This perforation was followed by confirming the apical closure with a size #30 K-file. The working length was determined in a radiograph with the first file that adjust in the apical region (size #80 K-file) (Fig. 3B), and filing was performed in the internal wall of the root canal.

The root canal was dried with sterile absorbing paper points. First, the apical filling, as well as the buccal defect in the middle third, was performed with 4 mm of white MTA (ProRoot MTA, Tulsa, OK), with a conveyor (MAP System, Universal Kit, Dentsply, Switzerland) and compacted with sequential Schilder instruments (Fig. 3C). Second, a size #80 gutta-percha cone was placed in the center of the root canal above to the previously adapted material (Fig. 3D), in order to maintain a permeable path with the apex in case an intra-radicular post or a conventional endodontic retreatment were required. White MTA was placed and condensed around the gutta-percha cone, filling the canal lumen and ensuring that the material was in contact with all the new hard tissue deposited in the internal walls of the root. Third, the free-end of the gutta-percha cone was removed, and the rest of the cavity was filled with a composite-based sealing material (3M ESPE FiltekTM Supreme XT, St Paul, USA). The final radiograph shows an adequate filling of the root canal system (Fig. 3E). Conventional post-operative recommendations were given, and the patient was referred for an adequate post-endodontic reconstruction. The 20-month follow-up showed no signs and symptoms of endodontic re-infection upon radiography and CBCT examination, as well as an aesthetic aspect of the tooth which was restored with a ceramic lithium disilicate veneer (Fig. 4).

DISCUSSION

As was emphasized by Spångberg[12], the endodontic community needs to be more focused in pulp preservation, leaving in the background the application of invasive procedures (as pulpectomy) whenever possible. This philosophy is particularly important in teeth with immature apex. However, it is not always possible to apply these concepts and when the pulp of immature teeth succumbs to necrosis, its management is complex even for an experienced endodontist. Nonetheless, the RR procedure is considered an alternative

Fig. 4. The 20-month follow-up reveals healthy periapical tissues. *(A)* **Intraoral front view of the patient in occlusion.** *(B)* **Follow-up digital radiograph. Selected CBCT follow-up images of tooth #21.** *(C-E)* **Longitudinal and** *(F-G)* **cross-section slices.**



of treatment in these cases, particularly when root development is interrupted in its early phase of formation and the root anatomy is still too frail.

Despite promising results, doubts regarding the ideal sequence of treatment of this therapy remains[4]. One of the prevailing questions is whether the procedure should be considered a permanent treatment. In general, the literature limits itself to the suggestion that these teeth will develop obliteration of the canal lumen and should have clinic-radiological follow-up, as they remain functional and free from disease for many years[13]. However, this assertion is open to discussion due to the lack of evidence from top-level studies confirming the long-term success of this treatment[5, 6]. Nygaard-Østby[2] showed in humans some cases of several degrees of internal root canal resorption after 10 months, although adequate clinic-radiological findings were observed. These outcomes could be related to intra-canal residual bacterial biofilm, which can compromise the long-term success[14]. Additionally, we should consider that obliteration of the root canal following the RR procedure, might lead to endodontic and prosthetic future complications.

It is known that an important factor for conventional root canal treatment failure is coronal microleakage of saliva[15]. Although failure due to this factor in the context of RR therapy is not yet reported, it is a latent possibility. However, an obliterated root canal also obstructs the adequate orthograde treatment of this new endodontic infection[16, 17], which commonly leads to technical complications such as root perforation or instrument breakage. Moreover, regardless the patient's age or gender, the risk of later dental trauma that compromise the remaining coronal structure and subsequent mandatory intra-radicular post placement is always present[18], which implies a high possibility of endodontic complications in teeth previously treated with RR technique.

In this case, we recommend the root canal filling once apical third was completed and radicular walls were wider, in order to maintain a permeable path through the pulpal space of the RR-treated teeth. The rationale for performing this treatment is similar to that from apexogenesis cases or partial amputation of a vital pulp where, to date, the clinical evidence is non-existent as to whether the treatment should be considered permanent; thus, prophylactic endodontic treatment is recommended[19, 20].

On the other hand, as reported in the literature in animal[7, 8] and human studies[9, 10], a mix of bone and cement comprised the tissue deposited in the pulpal space after RR procedure. Thus, a biocompatible material with the periapical tissues, such as MTA, was selected[21]. Due to its physical/chemical/biological properties, which provides good clinical and histological results, makes it the filling material of choice in this case.

To our knowledge, there are only four reports in the literature on treatment with the RR technique and posterior intra-canal filling; however, these case studies were performed due to complications during follow-up and were not meant as comprehensive treatment proposals. Torabinejad & Faras[22] filling a maxillary second premolar with a sealer/gutta-percha mix due to reversible pulpitis symptoms. Nosrat *et al.*[23] adapted MTA in the main canal of a maxillary central incisor for negative response to vitality test. Glassman[24] reported the accidental root canal filling, performed by a dentist who was unaware of the RR technique, with a sealer/gutta-percha mix on a mandibular second premolar. Žižka *et al*.[25] carried out an apexification procedure (MTA apical barrier) in a maxillary central incisor due to sinus tract appearance after 3 months to RR protocol. However, this paper is the first to suggest the prophylactic filling of the main canal in teeth previously summited to successful RR treatment.

CONCLUSION

For prophylactic reasons, it is possible to perform filling of the main canal of a tooth with a previous RR treatment once the increased thickening of the radicular walls, incrementing the root length, apical closure and the total resolution of the apical lesion are observed. We presented the clinical and radiographic results 19 months after a re-intervention of a healed case that was treated previously with the RR procedure, due to the lack of the patient's adherence to the follow-up protocol.

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