REGENERATIVE ENDODONTIC PROTOCOL IN IMMATURE TEETH: CLINICAL CASE REPORTS

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ABSTRACT

Aims: This paper aimed to describe the treatment protocol for immature teeth with necrotic pulp by inducing revascularization and using bioceramic material.

Case report: Case 1 presents a dens invaginatus type I in the tooth (#22) with tooth mobility, pulp necrosis, and the presence of a fistula. Case 2 shows tooth (#35) with an atypical incomplete root apex formation. Irrigation was performed with 3% sodium hypochlorite gel, 17% EDTA, and 2% chlorhexidine digluconate in both cases. Calcium hydroxide dressing was kept in the root canals for 30 days. Then, apical bleeding was induced, root canals were filled with blood clots and bioceramic material was placed in the cervical third.

Results: After 4-year and 2-year follow-ups, clinical and radiographic evaluations highlighted periapical bone repair and tooth function.

Conclusions: The long-term results suggest that the regenerative endodontic protocol used was successful and can be a therapeutic option for immature teeth with pulp necrosis.

KEYWORDS: Dentin. Calcium hydroxide. Dental pulp. Regenerative endodontic treatment. Revascularization.

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INTRODUCTION

Teeth with incomplete apex and pulp necrosis remain a challenge for dental clinicians, despite many procedures having been proposed for their resolution[1-5]. Conservative approaches are the most recommended procedures, such as induction of apexification using intracanal medication with calcium hydroxide, or endodontic obturation after collagen and MTA apical barrier[5,6]. However, the use of intracanal medication with calcium hydroxide requires a longer treatment time until the root canal obturation has been completed[6]. As a result, the risk of contamination and tooth fracture may increase[4-7].

Apical barrier using calcium hydroxide, bioceramic material, with or without collagen membrane placement followed by root canal obturation has been recommended to optimize the treatment time and minimize the negative effects from long-term of intracanal medication[5,8].On the other hand, the apical barrier technique requires technical experience from the dental clinician, once the residues from endodontic materials reach the periapical region causing a biological

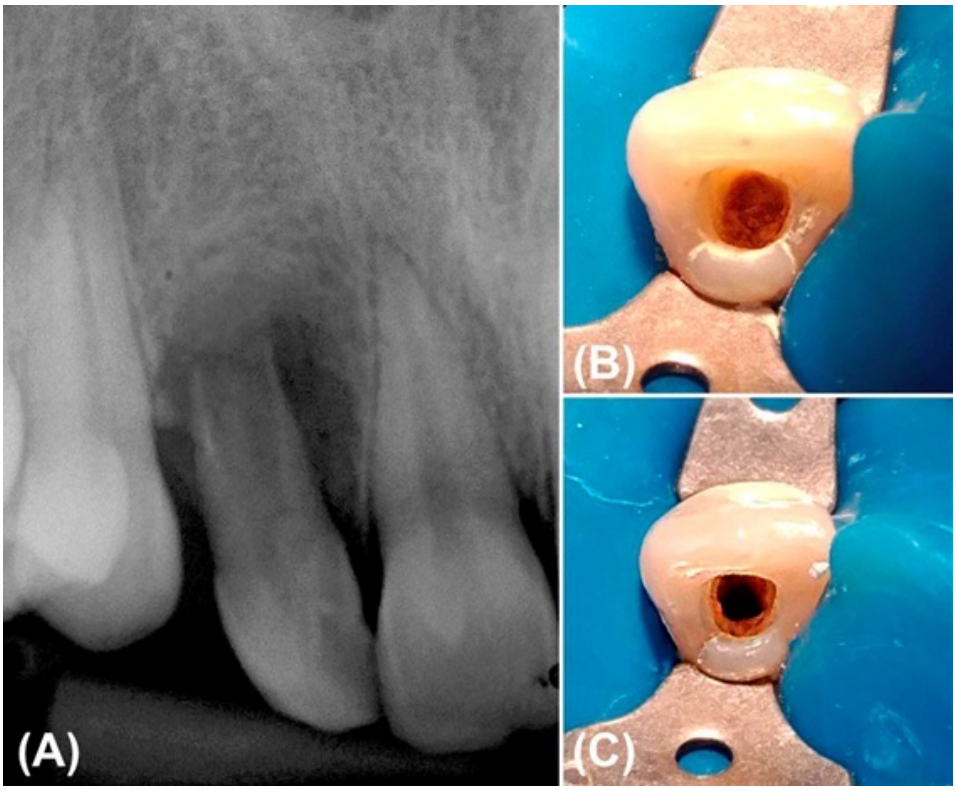

Figure 1. A. Rarefaction image around the root surface of the tooth (#22). **B.** Initial access to the pulp chamber. **C.** Pulp chamber access was successfully carried out.

response that is still uncertain[9-11]. Furthermore, these residues may persist on the root surface leading to an interface that may compromise the bonding between dentin substrate and sealer[12,13].

Regarding the cell regeneration potential of dental pulp, periodontium, blood vessels, and immune system, mainly in teeth with incomplete root formation, clinical strategies have recently been suggested, such as revascularization and regeneration of pulp[14]. Moreover, several protocols have been proposed for pulp revascularization and regeneration pulp using remaining cells from dental pulp, blood vessels of the periodontal ligament, or even stem cells[15-17]. However, no treatment protocol has been well established for revascularization induction and endodontic regeneration in immature teeth with necrotic pulp.

Thus, we aimed to report two clinical cases of revascularization and regeneration pulp in immature teeth with necrotic pulp, the first with an immature apex presenting *dens invaginatus* type I anomaly 18 and the second presented tooth with partial root apex formation and lateral root resorption. A 2-year follow-up was recorded.

CASE REPORT

Case 1

A 13-year-old female patient was referred to dental health care due to severe tooth mobility (#22). Clinical history reported that the tooth presented excessive mobility in the bucco-lingual direction for approximately 1 year. Clinical examination confirmed the tooth mobility with *exacerbated pain* in both horizontal and vertical percussions, and the presence of a fistula in the alveolar mucosa near to root apex.

Although the dental crown was intact, an anatomic defect with two grooves in the enamel structure was observed in the cervical third of the palatal face. Pulp sensitivity test (Endo-Frost; Wilcos, Petrópolis, RJ, Brazil) indicated an absence of response to thermal tests. Radiographic evaluation revealed an extensive radiolucent periradicular image and root apex incompletely formed in the tooth (#22). In addition, a *dens invaginatus* type I was observed in the pulp chamber. **Figure 1A** shows a bone rarefaction image around the root surface of the tooth (#22) with *dens invaginatus* into the pulp chamber, and immature root apex.

Firstly, *dens invaginatus* was worn using a diamond bur #1012 (KG Sorensen, São Paulo, SP, Brazil) in a high-speed handpiece, under water-cooling until the exposure of the root canal. **Figures 1B** and **1C** show the initial access to the pulp chamber, and pulp chamber access successfully carried out, respectively.

After coronal access, the pulp chamber was irrigated with 3% sodium hypochlorite gel (ChlorCid V, Ultradent, South Jordan, UT, Brazil), and the chemical-mechanical preparation was performed over the entire length of the root canal using # 50 to # 80 K-files. The root canal was irrigated with 2 mL of 3% sodium hypochlorite gel (ChlorCid V, Ultradent, South Jordan, UT, Brazil) at each instrument change.

Then, the root canal was irrigated with 20 mL of saline solution and submitted to absolute aspiration (Capillary Tips 0.014; Ultradent, South Jordan, UT, USA), and again irrigated with 17% EDTA (Biodynamic, Ibiporã, SP, Brazil) for 3 minutes. After that, a final irrigation was performed with 10 mL of saline solution.

The root canal was filled with calcium hydroxide paste (Ultracal, Ultradent, South Jordan, UT, USA), and the coronal access was provisionally restored with glass ionomer cement (Maxxion R, FGM, Joinville, SC, Brazil). Intracanal dressing was kept for 30

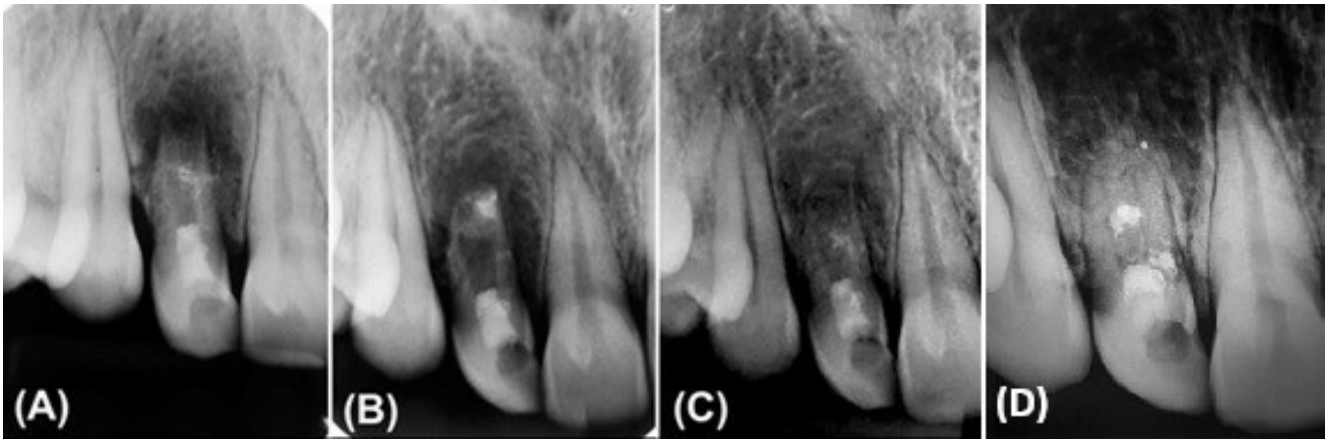

Figure 2. A. Root canal filled with calcium hydroxide medication. **B.** Bone repair in the tooth (#22) region, after 1-year follow-up. **C.** Bone repair in the tooth (#22) region, after 2-year follow-up. **D.** Bone repair in the tooth (#22) region, after 4-year follow-up.

days. **Figure 2A** displays the root canal filled with calcium hydroxide medication.

Subsequently, intracanal medication was removed with 3% sodium hypochlorite gel (ChlorCid V; Ultradent, South Jordan, UT, USA), and 17% EDTA irrigation. Afterward, irrigation was performed again with saline solution and 2% chlorhexidine digluconate (Pharmacia Specfica, Bauru, SP, Brazil), and then aspirated with aspiration tips. After that, apical bleeding was induced by passing files and the root canal was filled with a blood clot to the middle third.

Bioceramic material (Bioaggregate; Innovative BioCeramix, BC, CA) was mixed according to manufacturer instructions and placed over the blood clot (3mm thick). The coronal access was restored with glass ionomer cement. **Figures 2B**, **2C,** and **2D** show favorable bone repair in the tooth (#22) region, after 1-year, 2-year, and 4-year follow-up.

After the treatment conclusion, no clinical signs or negative. In the radiographic image (**Figure 2D**) control shows alveolar bone formation and increased thickness radicular wall.

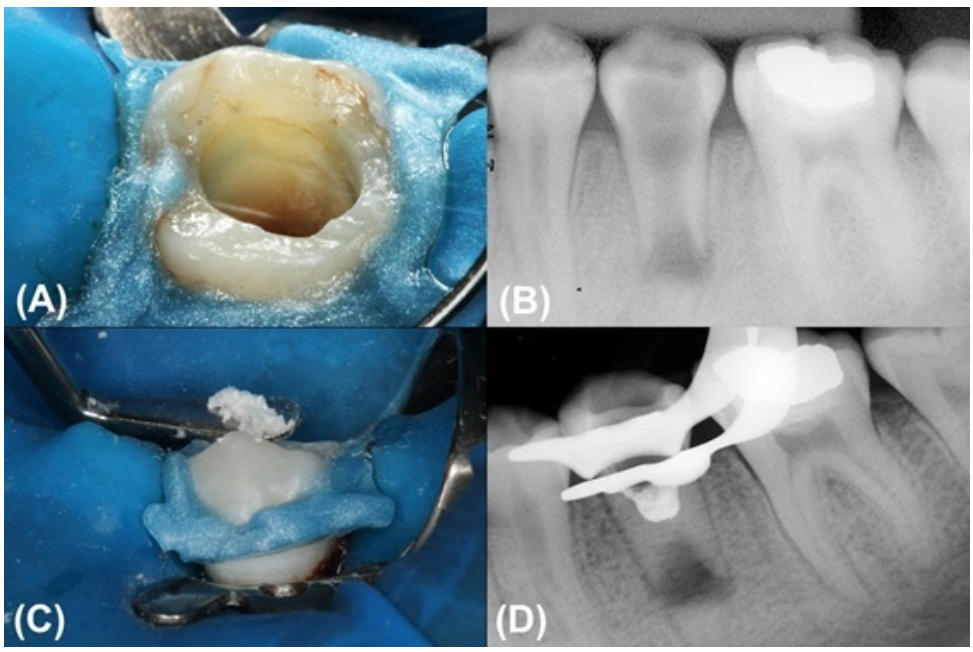

Figure 3. A. Initial image of tooth (#35). **B.** Radiographic image of atypical root formation with incompletely formed apex. **C.** Bioceramic material placement into the pulp cavity. **D.** Radiographic image taken after the treatment completion.

Case 2

A 14-year-old female patient was referred to dental health care due to the presence of spontaneous pain in the tooth (#35), which was exacerbated by chewing. Clinical history reported that she did not return to complete the endodontic treatment for approximately 1 year. The patient also reported that coronal access presented no provisional restoration more than 6 months ago.

Clinical examination showed that the root canal was accessed. The tooth presented slight sensitivity to vertical percussion, and an absence of response to the thermal test (Endo-Frost; Wilcos, Petrópolis, RJ, Brazil). Radiographic analysis revealed an atypical root formation with a partially formed root. **Figures 3A** and **3B** display the initial image of the tooth (#35), and radiographic image of atypical root formation with incompletely formed apex.

The pulp chamber was irrigated with 3% sodium hypochlorite gel (ChlorCid V, Ultradent, South Jordan, UT, Brazil). Root canal instrumentation was minimally invasive over the entire length of the root canal using electronic odontometry (Romiapex A-15;

Romidan, Kiryat Ono, ISR), from K-file # 50 to # 80. The root canal was irrigated with 3% sodium hypochlorite gel (ChlorCid V; Ultradent, South Jordan, UT, USA), at each instrument change.

After mechanical-mechanical preparation, the root canal was irrigated with saline solution, 17% EDTA for 3 minutes, irrigated with saline solution, aspirated with endodontic tips (Capillary Tips 0.04; Ultradent, South Jordan, UT, USA), and then irrigated with 2% chlorhexidine digluconate (Pharmacia Específica, Bauru, SP, Brazil). After an endodontic aspiration, the root canal was filled with calcium hydroxide medication (Ultradent, South Jordan, UT, USA).

Thirty days later, intracanal medication was removed with 3% sodium hypochlorite gel, 17% EDTA, and saline solution. Afterward, apical bleeding was induced similarly to that described earlier, and the root canal was filled with a blood clot to the middle third.

Bioceramic material (Bioaggregate; Innovative BioCeramix, BC, CA) was mixed according to manufacturer instructions and placed over the blood clot (3mm thick). The coronal access was restored with glass ionomer cement. **Figures 3C** and **3D** show the bioceramic material placement into the pulp cavity, and a radiographic image taken after the treatment completion.

Figures 4A, **4B**, **4C,** and **4D** display radiographic images, with alveolar cortical bone formation and maintenance of tooth function, after 1, 6, 12 months, and 2-year follow-ups, respectively.

Similar signs and symptoms in follow-up control, as previously described in case 1, were observed in this clinical case, alveolar bone formation and increased thickness of the radicular wall.

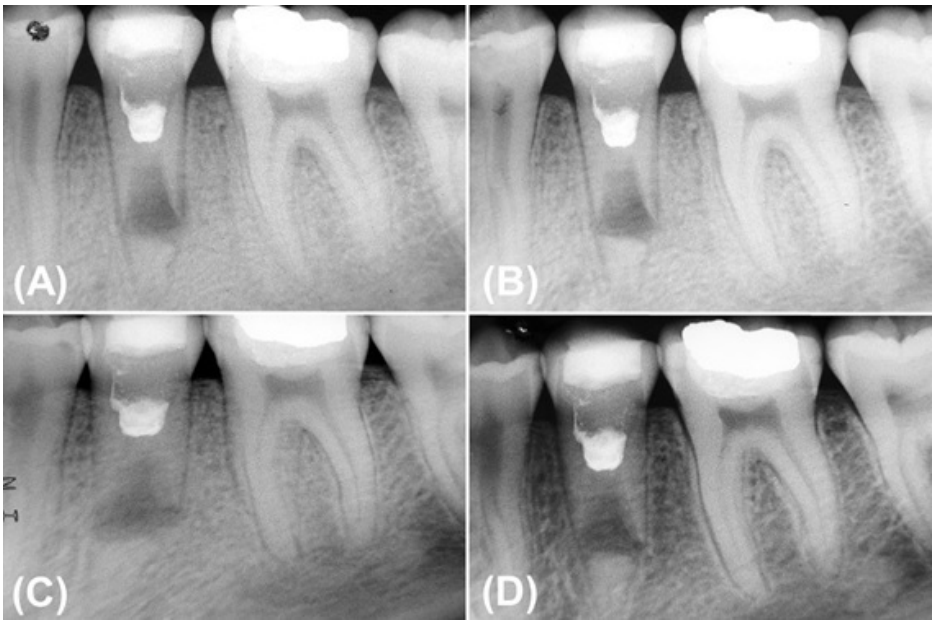

Figure 4. A. Radiographic image with alveolar cortical bone formation and maintenance of tooth in function, after 1 month. **B.** After 6 months **C.** After 12 months. **D.** After 2-year follow-up.

DISCUSSION

Clinical resolution of teeth with incompletely formed apices is still controversial and unclear[1,3,4]. Regenerative endodontics is a milestone in the technique evolution; however, the treatment protocols need to be more established[6,7]. The prognosis of endodontic treatment may achieve clinical and radiographic success, such as the maintenance of tooth esthetic and function; however, all treatment strategies should be properly indicated for each clinical situation[1,8].

Both clinical cases reported pulp necrosis, which was clinically confirmed after a thermal sensitivity test and pulp chamber access. Thus, the control of bacterial contamination inside the root canals is crucial to achieve successful results.

3% Sodium hypochlorite gel was selected for root canal irrigation due to its higher viscosity, to avoid its overflow beyond the apical limit[19]. Gel formulation presents less antimicrobial activity than solution formulation, so, we performed a previous irrigation with 6% NaOCl solution only in the pulp chamber, mainly in the second clinical case, in which a canal communication with the oral environment for more than 6 months was reported[20,21].

The infection control of the root canal plays an important role in the success of revascularization procedures in teeth with incomplete apices[1,3]. Intracanal medication has been claimed to contribute to microorganism elimination and to favor the apical repair process[14]. Medication with minocycline, metronidazole, and ciprofloxacin (triantibiotic paste) is the most used in the revascularization of incomplete apex with necrotic pulp, due to its satisfactory antimicrobial activity on the biofilm in the root canal[22,23]. However, the present study avoided this medication due to the risk of tooth staining[24].

Thus, the intracanal dressing containing calcium hydroxide was selected due to its antimicrobial activity on the microorganisms in the root canal of teeth with incomplete apices[22-25]. Despite calcium hydroxide paste presenting lower antimicrobial activity than triantibiotic paste, this study compensated for it by the root canal irrigation with 3% sodium hypochlorite gel, to provide a

synergism between intracanal medication and irrigation agent[21,22, 25].

Bioceramic material was used on the blood clot formed in the root canal. Even though several materials have been proposed for regenerative endodontics, MTA is still the most recommended[1,3,5,14,15]. Thus, bioceramic material (Bioaggregate) was chosen since it contains tricalcium silicate, tantalum oxide, calcium phosphate, and silicon dioxide and is free of aluminum zirconium oxide[26]. Furthermore, bioceramic material presents biological and physicochemical properties that are favorable for the revascularization process of immature teeth with necrotic pulp[26].

Therefore, both clinical cases showed that microbial control associated with the proper technique and materials favored the tooth revascularization and regeneration pulp by performing a conservative and esthetic approach that maintained tooth function and esthetics after follow-up.

CONCLUSION

The long-term results achieved with the microbial control strategy using endodontic irrigation with 3% sodium hypochlorite gel, calcium hydroxide intracanal dressing, revascularization via blood clot formation into the root canal, and bioceramic material placement suggest that this regenerative endodontic protocol was successful and can be a therapeutic option for immature teeth with pulp necrosis.

DECLARATION OF PATIENT CONSENT

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published, and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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