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The Impact of Vital Pulp Therapy on Normal Root Development in Immature Teeth: A Case Report

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Vital pulp therapy is one of the least invasive and simplest and most economically acceptable treatment alternatives for immature teeth with pulpitis. The success rate of this treatment, with calcium silicate-based cements, ranges from 85% to 100%. Vital pulp therapy prevents the development of apical periodontitis and promotes normal root development, allowing the tooth to remain in the dentition and perform its functions. The patient was a nine-year-old boy with pain on chewing and a positive response to cold. The panoramic radiograph showed an immature permanent lower molar with deep caries. Partial pulpectomy and root pulp sealing with pre-mixed calcium silicate-based cement were performed under aseptic conditions. The absence of symptoms and the formation of roots with apical sealing were successfully achieved and observed by follow-up and radiographic control, making this treatment a viable option for immature teeth with pulpitis.

Keywords: Dentistry; Microscopy; Pulp Pathology; Pulpitis; Vital Pulp Therapy

Introduction

Vital pulp therapy (VPT) offers significant benefits for both mature and immature teeth by maintaining the vitality of the pulp tissue, which promotes continued root development, preserves tooth structure and enhances healing potential [1].

This therapeutic approach not only facilitates pulp regeneration and apex formation, but also promotes apical closure, which is essential for preventing future complications such as infection or root fractures. Maintaining pulp vitality creates a biological environment that promotes tooth growth and maturation, resulting in increased strength, function and long-term longevity of the tooth [1, 2].

When we encounter clinical cases of immature teeth, they usually present open apexes, thin root walls and incomplete root formation, so we refer to the guidelines of the endodontic societies to determine the appropriate treatment [3]. The aim is to minimize the complications of conventional root canal treatment in cases of incomplete root formation [3].

Vital pulp therapy includes various types of pulpotomy, including miniature pulpotomy, partial pulpotomy and full pulpotomy [10]. Another modality of VPT is partial pulpectomy, it involves the removal of the infected portion of the pulp tissue from the root canal system, while preserving pulp vitality. Partial pulpectomy often serves as a less invasive alternative to full pulpectomy or conventional root canal treatment [10].

. The success of partial pulpectomy depends mainly on its execution, that is, on anesthesia, isolation, asepsis, adequate control of intraoperative bleeding and hemostasis, which must be achieved to preserve vital root pulp [4].

Calcium silicate-based cements are essential in VPT because of their biocompatibility, ability to stimulate repair, sealing efficacy, ease of use and positive clinical results comparable to those of conventional endodontics in teeth with pulpitis [5, 6].

Partial pulpectomy is a less invasive, cheaper and simpler option for preserving pulp vitality compared to root canal treatment in immature permanent teeth, which can reduce the risk of complications and improve the patient experience [6, 7]. The aim of this article is to present a clinical case of an immature second left mandibular molar diagnosed with pulpitis in which partial pulpectomy as one the VPT methods was performed, with a 3-year clinical and radiographic follow-up.

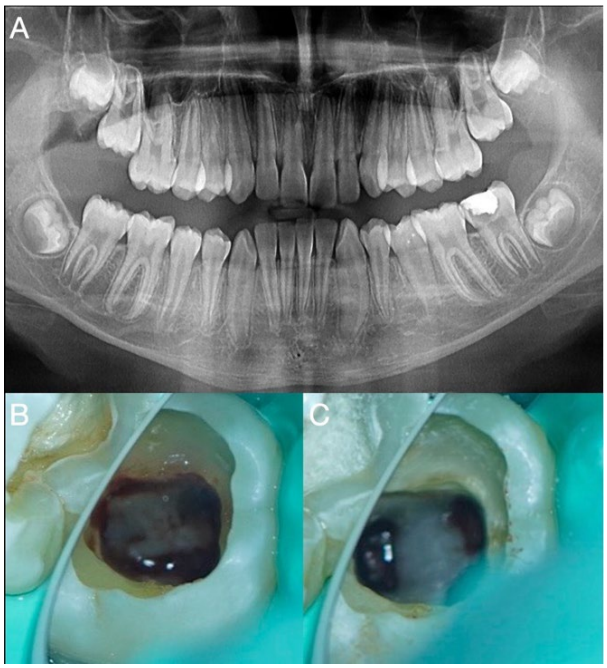

Figure 1. *A*) Panoramic radiograph showing deep caries; *B*) Endodontic access cavity; *C*) Control of hemostasis

Case report

This case report has been written according to the Preferred Reporting Items for Case Reports in Endodontics 2020 guidelines [8]. A 9-year-old male patient was visited for evaluation and root canal treatment of a permanent lower left second molar.

The patient's complaint was pain while chewing and constant pain when drinking hot and cold beverages. The mother provided a panoramic radiograph at the initial consultation (Figure 1A), as requested by the patient's general dentist.

The patient's medical history did not reveal any significant personal or family history. His mother reported that, before being referred to the endodontic clinic, the patient had been given formocresol medicament and a temporary filling, additionally, a suspension of ibuprofen 200 mg/5 mL, 9 mL every 8 h for 3 days was prescribed.

The clinical examination revealed the presence of a temporary occlusal filling in the second left mandibular molar. The tooth responded positively to vertical and horizontal percussion and to thermal pulp sensitivity test evaluated using a refrigerant spray (Endo-Ice®, Coltene/Whaledent Inc., Altstätten, Switzerland), with an exaggerated response to cold that lasted more than a min after applying ethyl chloride on a cotton swab as a stimulus. The antagonist and adjacent teeth, as well as the tooth on the opposite side, responded normally to the pulp sensibility tests.

Periodontal probing depths and mobility were within normal limits in comparison with the teeth on the opposite side and adjacent teeth. All teeth in the quadrant responded within normal limits to vertical and horizontal percussion.

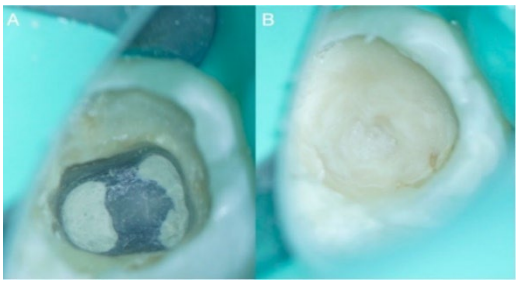

Figure 2. *A*) Placement of Bio-C Repair in the root pulp; *B*) Sealing with glass ionomer

Panoramic radiograph showed deep caries at the level of the pulp chamber in close proximity to the mesial pulp horn (Figure 1A), incomplete root development with thin root walls, and open apexes. After a thorough clinical and radiographic examination, the definitive diagnosis was symptomatic pulpitis in the second left mandibular molar.

The patient and his mother were informed of the clinical and radiographic findings, as well as the treatment options. Several alternatives were presented: all options regarding VPT, apical plugging with a bioceramic material in case adequate control of the bleeding could not be achieved, and, finally, extraction of the tooth.

The mother and the patient opted for either of the VPT alternatives to avoid extraction of the tooth. Informed consent was obtained from the mother. Anesthesia was achieved by blocking the inferior alveolar nerve with lidocaine hydrochloride 2% with epinephrine 1:80,000. Once the patient's anesthesia was confirmed, absolute isolation was carried out and the treatment resumed.

During the treatment, a surgical microscope was meticulously used (Deciduos, DFVasconcellos, Rio de Janeiro, RJ, Brazil). The temporary filling and medicated cotton were removed to check the extent of the caries. Exposure of the pulp was observed at the level of the mesial pulp horn, with ischemic and yellowish pulp, and the entire roof of the pulp chamber was afflicted with deep caries. The carious lesions were removed with a 1015 round diamond bur (Microdont, Goias, Brazil). During the process of removing the caries, more pulp tissue from the chamber was exposed; therefore, endodontic access was made in the conventional way, removing the roof of the chamber with an EndoZ bur (Dentsply Maillefer, Ballaigues, Switzerland)(Figure 1B).

The healthy pulp retained its bright red color after removing the ischemic pulp tissues that had been in contact with the medicated cotton. Given the state of root development and pulp inflammation, a partial pulpectomy was performed manually with a double excavator (Dentsply Maillefer, Ballaigues, Switzerland) and the access cavity was irrigated with 1% sodium hypochlorite. Hemostasis was controlled with sterile cotton wool soaked in 1% sodium hypochlorite for 5 min (Figure 1C).

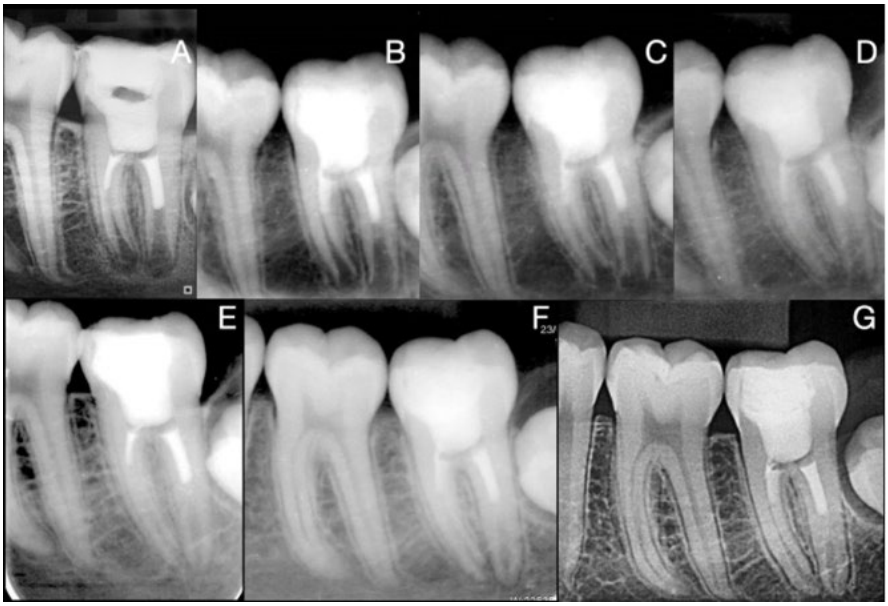

Figure 3. Control and follow-up periapical radiographs of the tooth at: *A*) After treatment; *B*) Three months; *C*) Six months; *D*) One year; *E*) Eighteen months; *F*) Two years; *G*) Three years

Once hemostasis was achieved, Bio-C Repair (BCR; Angelus, Londrina, PR, Brazil) was applied directly to the mesial and distal root pulp (Figure 2A). After confirming adequate sealing and the absence of bleeding, a restorative glass ionomer (Ketac Molar Easymix. 3M Espe, Irvine, California, USA) was immediately placed (Figure 2B). A periapical control radiograph was taken (Figure 3A).

The patient was advised to undergo immediate definitive restoration and regular follow-up visits were scheduled to monitor clinical signs and symptoms, as well as root development, using periapical radiographs. At the three- and six-month follow-up visits, no root development was observed and the patient was asymptomatic (Figures 3B and 3C). At one-year follow-up, thickening of the root walls was observed in the mesial and distal roots (Figure 3D). After eighteen months, apical sealing of the distal root and greater thickening of the mesial root was observed (Figure 3E). At the two- and three-year follow-up, complete root development with apical sealing was observed and the patient did not present associated symptoms (Figures 3F and 3G).

Discussion

Currently, different vital pulp therapies have been recognized, such as stepwise excavation, indirect pulp capping, direct pulp capping, miniature pulpotomy, partial pulpotomy, complete pulpotomy and partial pulpectomy. All of them are considered alternative treatments for maintaining pulp vitality in primary and permanent teeth, both mature and immature, in which root development can be induced in teeth affected by deep and extensive caries [9].

Before undergoing this treatment, the patient must be well informed about probable complications such as bleeding control, possible inadequate removal of inflamed pulp tissue, and the lack of standardized protocols that may affect the predictability of treatment. The extent of decay and the inflammation of the pulp, which in this case was observed to be ischemic and with purulent exudate, are important factors determining the success rates when making decisions about performing VPT [1, 10].

The main challenge in treating immature permanent teeth with deep caries is maintaining a balance between adequate removal of the dentin and pulp tissue affected by bacteria, and adequate protection of the pulp to maintain its vitality and facilitate root development [11]. In the present case report, extensive pulp exposure was observed, as well as deep caries which, when removed, left the entire pulp tissue exposed.

Treatment success rates can be influenced by the accuracy of pulp diagnosis (which is currently not well-defined for this type of VPT) [6], the use of aseptic techniques, adequate removal of affected dentin, the size of the pulp exposure, adequate control of bleeding and the material used to protect the pulp. Inadequate pulp treatment without complete disinfection of the affected pulp space may lead to failure of the treatment of choice and compromise the longevity of the tooth [12].

Various materials are used in vital pulp therapy (VPT) procedures. Calcium hydroxide has been widely used, particularly in apexification treatments. However, its clinical effectiveness is limited due to the need for multiple appointments, which increases the likelihood of treatment failure [10].

Mineral trioxide aggregate (MTA) has emerged as a more modern alternative. It has demonstrated higher success rates in

pulpotomy procedures, making it a favorable option in many clinical scenarios. Still, it poses significant technical challenges, such as difficult handling and a tendency to overfill the root canal. It is also associated with adverse effects like tooth discoloration [12].

Both materials can interfere with normal root development. This may lead to immature roots, thin dentinal walls, an unfavorable crown-to-root ratio, and disruption of periodontal ligament integrity. These structural deficiencies increase the risk of fracture and compromise the long-term prognosis of the treated tooth [12, 13].

In recent decades, biocompatible materials have been developed for intimate contact with pulpal tissues. Among them are the calcium-enriched mixture (CEM), Biodentine and BioCRepair, which promote dentinogenesis and tissue regeneration and induce a mild inflammatory response. They also promote repair and contribute to the mineralization process of periapical tissues by demonstrating their bioactive potential [9, 13].

In this case, the calcium silicate-based cement used formed a suitable antimicrobial seal, did not induce staining of the dental organ, and was not cytotoxic to osteoblastic cells, which favored root development. The main objective of using calcium silicate-based cement, when pre-mixed, is to improve the properties of its predecessor materials, facilitating its use and thus avoiding waste; therefore, this material should be considered as an affordable and low-cost repair material in VPT [14].

The case presented in this study was followed for a minimum of three years, demonstrating that partial pulpotomy had a long-term effect on root development and apex formation. Few studies show a high success rate and are mostly related to regenerative endodontic treatments [1, 11, 12].

Conclusion

The absence of symptoms and the formation of roots with apical sealing were achieved by partial pulpotomy using a pre-mixed calcium silicate-based cement and aseptic control within the pulp chamber. The favorable evolution was demonstrated by follow-up and radiographic control, making it a viable treatment for immature teeth with pulpitis.

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Authors' contributions
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