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CASE REPORT

A contemporary approach to treat necrotic immature teeth using different bioceramic materials

ABSTRACT

Aim: *The present report describes the endodontic treatment of an immature maxillary central incisor with an open apex and extensive periapical lesion.*
Summary: *Cone-beam computed tomographic images demonstrated the unusual root canal anatomy and a contemporary approach using bioceramic intracanal dressing, root repair materials and root canal sealers were used. One year after the end of treatment, the patient was asymptomatic and a new cone-beam computed tomographic exam showed complete apical repair, with deposition of mineralized tissue and closure of the root apex. The combination of modern imaging and the use of contemporary materials contributed to adequate diagnosis, planning and treatment of this case.*
Key-learning points

- *Immature permanent teeth with apical periodontitis represent a clinical challenge.*
- *Calcium silicate-based materials are widely used in endodontics, mainly due to their excellent biological and physical properties.*
- *The association of different type of calcium silicate-based materials could be a good option of the treatment of immature permanent teeth with apical periodontitis.*

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Introduction

Immature permanent teeth with apical periodontitis represent a clinical challenge. The presence of a wide root canal, which hinders effective decontamination; the fragility of the dentinal walls; and the presence of a wide foramen are the greatest difficulties for an adequate prognosis of these teeth. Apexification with calcium hydroxide has been widely proposed for these cases. However, there are major disadvantages within this therapy, mainly related to long treatment time, unpredictability in the formation of the apical barrier (1, 2), risk of root fracture due to prolonged exposure to calcium hydroxide (2) and persistence of a short root with thin walls (3).

New therapies such as performing apical barriers with biomaterials, which allow safe root canal filling in a reduced number of sessions, have been recommended. For these techniques, calcium silicate-based materials are suggested due to their excellent biological and physico-chemical properties (4-6). Based on these favorable properties, calcium silicate-based materials also started to be marketed as root canal sealer and intracanal dressing, bringing a new therapeutic aspect in endodontics. When used as root canal sealer, these materials have shown tissue compatibility (7), bioactivity with calcium release (8, 9), strong alkalinization activity (8, 10), good bond strength and excellent adhesion pattern to the root canal walls (11), radiopacity (8, 10, 12) and adequate flow (10).

Recently, a new ready-to-use bioceramic intracanal dressing, composed of tricalcium and dicalcium silicates, tricalcium aluminate and calcium oxide, was launched on the endodontic market (Bio-C Temp; Angelus, Londrina, Brazil). According to the manufacturer this is a biocompatible material, with high alkalinity (pH 12±1) and high radiopacity. It also has in its composition a long chain polymer, which prevents the interlacing of the crystals formed, preventing the product from hardening, and facilitating its removal (http://www.angelusdental.com/products/details/id/214).

The present case report describes the treatment of an immature permanent tooth with an open apex and extensive periapical lesion, in which bioceramic intracanal dressing, root repair materials and root canal sealers were used.

Case Report

The PRICE guidelines were followed in this manuscript (Supplementary figure 5) (13). A 14-year-old girl was referred for evaluation of tooth #8, with a previous history of dental trauma, two years earlier. On clinical examination, the patient was symptomatic, with tooth discoloration, edema without floating point, negative response to cold pulp vitality test (Endofrost; Roeko, Langenau, Germany) and positive responses to vertical and horizontal percussion and apical palpation tests. The cold pulp vitality test was also performed on teeth #7 and #9, with positive responses in both.

On periapical radiographic exam, a short root with a wide canal and open apex was observed, associated with extensive periapical lesion (Figure 1). Cone-beam computed tomography (PreXion 3D Inc., San Mateo, CA, USA) revealed an extensive unilocular lesion with defined limits, expansion of bone cortical, with rupture of the vestibular and lingual bone crest, associated with the roots of teeth #8 and #7. Also, it was possible to observe the presence of external apical root resorption and open apex only in the palatal face, in the teeth #8 (Figure 2 and Supplementary video 1).

Based on clinical and imaging findings, an acute dentoalveolar abscess was diagnosed and endodontic treatment was proposed. The proposed treatment was discussed and authorized by the patient's legal responsible, through the informed consent form.

In the first appointment, after local anesthesia and rubber dam isolation, access cavity was performed, and the canal was copiously irrigated with 2.5% sodium hypochlorite (NaOCl). Then, the working length (WL) was established using a size 80 K-file (Dentsply-Maillefer, Ballaigues,

Figure 1
Initial periapical radiography of tooth #8.

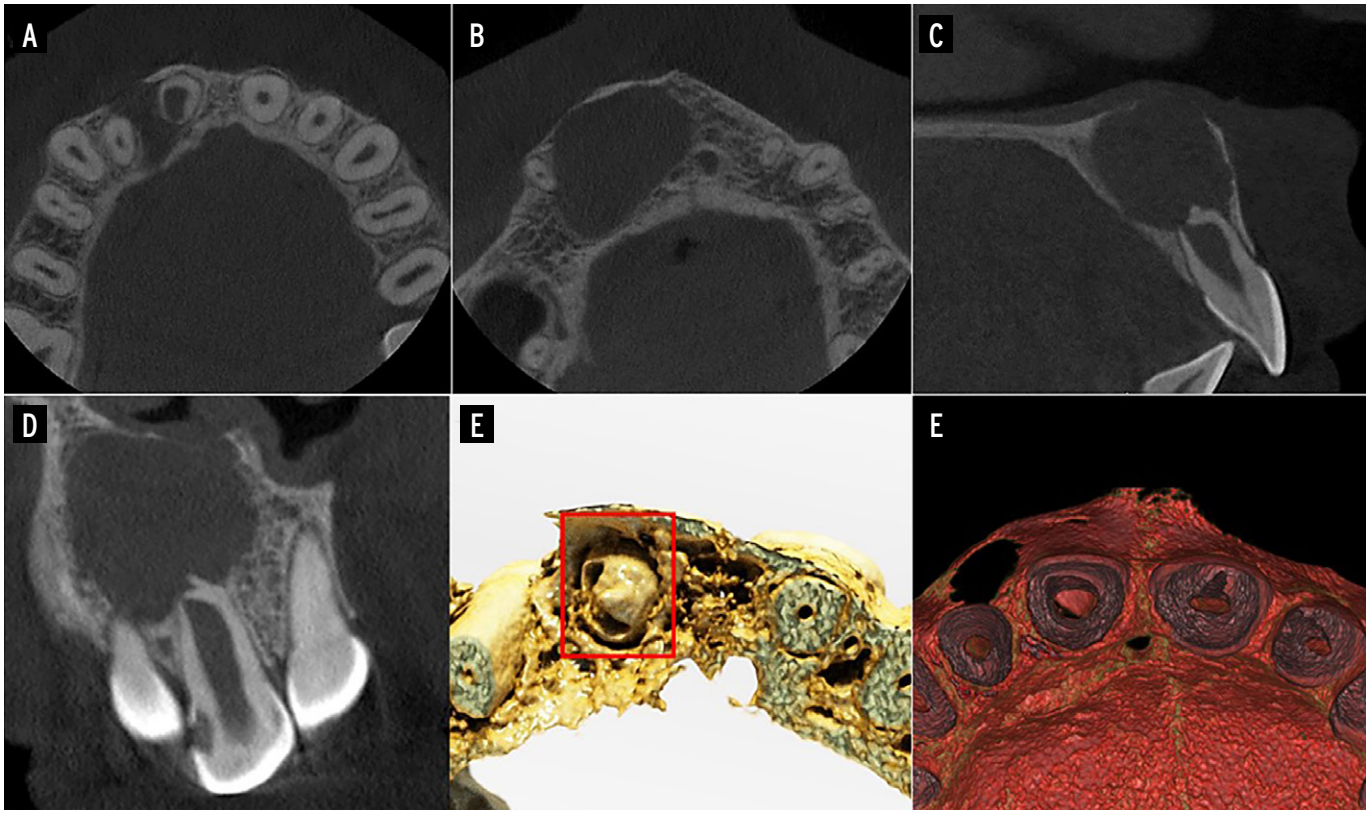

Figure 2
Initial cone-beam computed tomography of tooth #8 (E-Vol DX software). **A)** Axial section of the root apical portion. **B)** Axial section of the apical region. **C)** Sagittal section. **D)** Coronal section. **E)** 3D reconstruction of the foraminal opening. **F)** Front 3D reconstruction.

Switzerland). At this point the tooth presented copious drainage of purulent secretion. A vigorous irrigation protocol was performed using 20 ml of 2.5% NaOCl with 4 cycles of activation using Irrisonic ultrasonic insert (Helse Ultrasonic, Florida, USA) 1 mm bellow the root apex. Afterwards, the intracanal bioceramic dressing Bio-C Temp (Angelus) was inserted and temporary coronal restoration with glass ionomer was performed.

For six months, three changes of intracanal dressing were performed, always under rubber dam isolation. In all sessions, an irrigation protocol was performed with activation of the irrigant, alternating the ultrasonic insert Irrisonic and the Easy Clean instrument (Bassi Endo, Florida, USA) coupled in a low rotation contra-angle. After the six months, the complete remission of signs and symptoms was achieved, with radiographic visualization of partial apical closure and deposition of mineralized tissue in the apex (Figure 3A). Therefore, root canal filling procedures were performed. Initially, an apical plug was made with Biodentine® bioceramic repair cement (Septodont, Saint-Maur-des-Fossés, France). After the initial setting time of 20 minutes, the root canal was filled with gutta-percha cone #140 and accessory cones (Denstply-Maillefer) and BioRoot RCS® bioceramic root canal sealer (Septodont). Down-pack procedures were performed using a medium-size thermoplasticizer tip (Bassi Endo, Belo Horizonte, MG, Brazil) and a heat source (Bassi Endo) 5 mm short of the WL. (Figure 3B). Backfill were then performed by injecting gutta-perch in 4-mm increments into the canal. A gutta percha obturation gun (Bassi Endo) with #23-gauge needle was set on 180 °C and gutta percha pellets (Bassi Endo) and NiTi pluggers (Bassi Endo) were used during backfilling procedures (Figure 3C).

For coronal restoration, the enamel surface was etched for 15s with 35% phosphoric acid Ultra Etch (Ultradent, Utah, EUA), washed for 20s and dried, avoiding desiccation. Then, two consecutive layers of Single Bond Universal Adhesive (3M, Minneapolis, MN, USA) were applied on enamel and dentin, dried with oil free

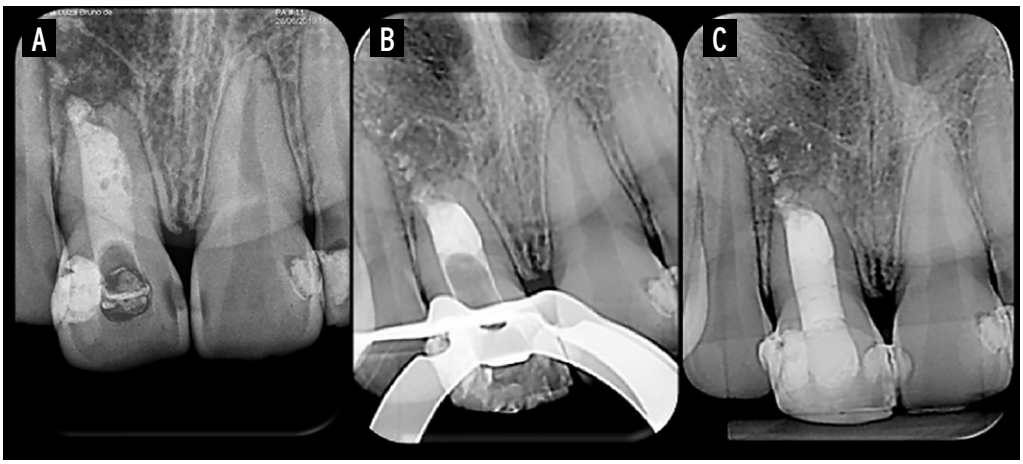

Figure 3
A) Radiographic aspect of the intracanal dressing Bio-C Temp on tooth #8. **B)** Apical plug with Biodentine and down-pack procedures in the apical third with BioRoot RCS. **C)** Final radiography after filling with backfill.

compressed air during 10s and cured for 20s with a led device Valo Cordless (Ultradent). Then, the cavity preparation was restored using a nanofilled composite resin A3 Filtek Z-350 (3M) in layers up to 2mm that were cured individually for 20s. All the procedures had been undertaken under rubber dam isolation.
In the 12-month follow-up, the patient was asymptomatic and without infection. Cone-beam computed tomography (PreXion 3D Inc., San Mateo, CA, USA) showed complete periapical repair, with deposition of mineralized tissue and root apex closure (Figure 4 and supplementary video 2).

Discussion

Regenerative endodontics is a viable therapeutic option with a high success rate for immature teeth, even in cases with periapical disease, as it allows for continued root formation in length, thickness and apical closure (14). However, in the present report, this treatment was not performed, since the apical root portion of tooth had already started its formation, with an opening only on the palatal surface, as observed in the cone-beam computed tomographic exam, which made the induction of bleeding into the root canal, indispensable for root maturation, unpredictable (14).
In the present case report, 2.5% NaOCl was constantly activated with ultrasonic insert and Easy Clean instrument. Literature demonstrates an improvement in the cleaning and disinfections of the root canal using final agitation protocols (15-19). Although highly effective, there are some concerns regarding the risk of apical extrusion in immature teeth. However, a recent study demonstrated that conventional irrigation without agitation caused the same extrusion pattern, in immature teeth, as the techniques activated with ultrasonic insert and mechanical agitation instruments such as Easy Clean (14). Such techniques have an important role in the treatment of immature teeth with thin walls, as instrumentation procedures must be minimal or even contraindicated.
Another important step for root canal disinfection is the use of intracanal dressing. In the present case, bioceramic dressing Bio-C Temp was chosen. According to the manufacturer, its advantage over calcium hydroxide pastes lies in its low solubility, allowing the use of this material for a long period of time, increasing the pH gradually and continuously, with no need of frequent substitutions. Furthermore, its particle is micronized (<2 µm), with an improvement in its physical properties such as greater flow and penetrability in the accessory canal and dentinal tubules; and with greater product reactivity and release of calcium and hydroxyl ions (http://www.angelusdental.com/products/details/id/214).
The new bioceramic dressing Bio-C Temp had acceptable cell viability, similar to that of MTA Flow (Ultradent) e UltraCal XS (Ultradent) at the highest dilutions, and resulted in less tooth colour change (20). When compared to calcium hydrox-

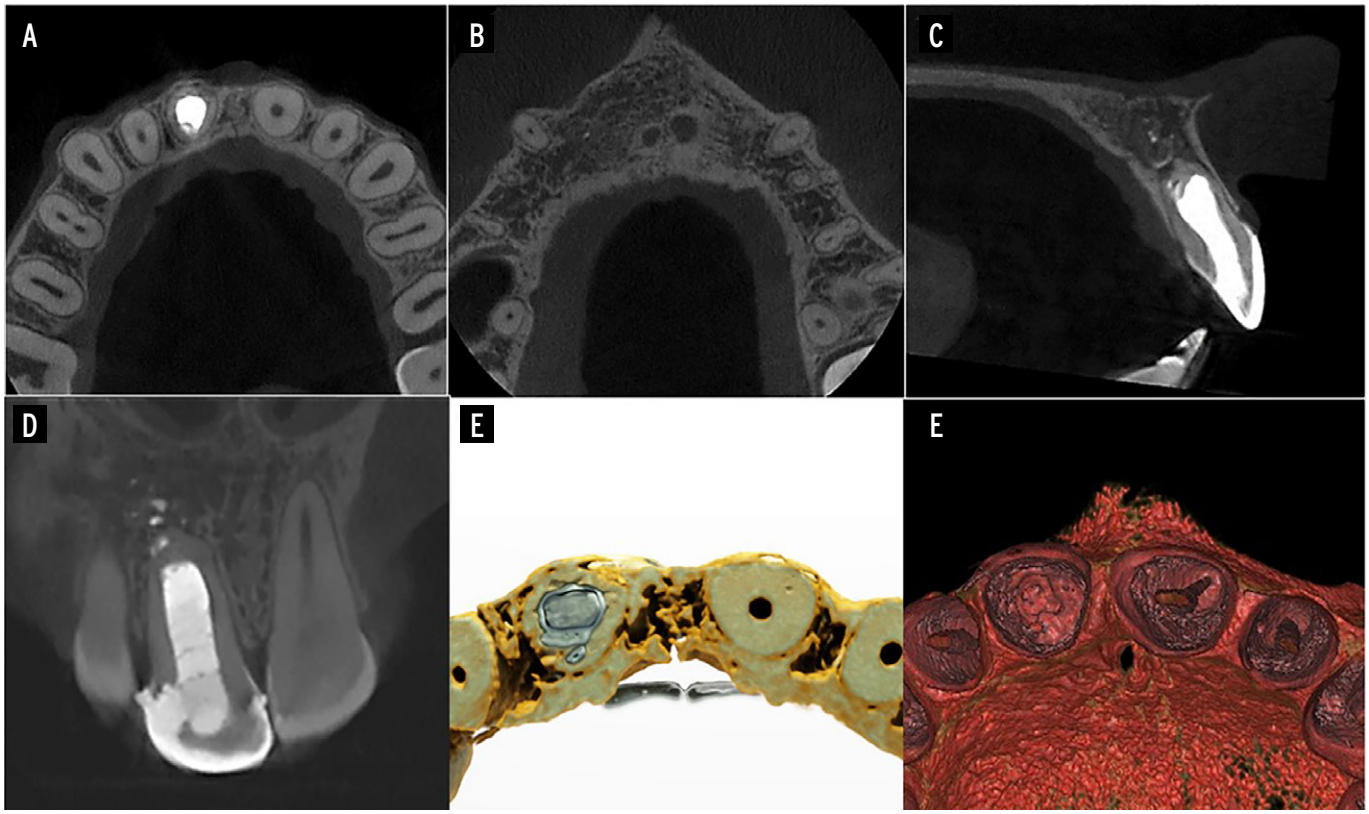

Figure 4
Cone-beam computed tomography 12 months after tooth #8 preservation (Software E-Vol DX). **A)** Axial section of the root apical portion. **B)** Axial section of the apical region. **C)** Sagittal section. **D)** Coronal section. **E)** 3D reconstruction of the root canal filling. **F)** Front 3D reconstruction.

ide-based intracanal medicaments, Bio-C Temp had similar cytocompatibility at higher dilutions, and higher or similar induction of alkaline phosphatase activity and deposition of mineralized nodules in comparison with Calen (SS White, PR, Brazil) and Ultracal XS (Ultradent). However, this new material showed significantly less antibacterial and antibiofilm activity than these other intracanal medicaments (21). Previous studies of calcium silicate-based materials also revealed excellent cytocompatibility and bioactive properties in direct contact with stem cells from human exfoliated deciduous teeth (22) and human dental pulp cells (23).
Biodentine cement was used during apical plug procedures, allowing root canal filling without risks of root canal sealer high extrusion. This is a bioactive dental substitute with excellent biological and mechanical properties, with emphasis on bioactivity (24), biocompatibility (25) and high resistance to compression (26). Also, its pre-dosed form, minimizes the operator's interference in the consistency and homogenization of the material (27).
BioRoot RCS root canal sealer was used during filling procedures. In a comparative study with the Pulp Canal Sealer, BioRoot RCS exhibited less toxic effect on cells of the periodontal ligament and induced greater release of angiogenic and osteogenic growth factors (28). Siboni et al. (8) also found that this sealer showed a greater release of calcium ions, with a higher capacity for forming carbonated apatite when compared to MTA Fillapex, AH Plus and Pulp Canal Sealer. This characteristic of bioactivity can contribute significantly to apical repair, inducing greater deposition of mineralized tissue, which is essential in extensive lesions.

Conclusions

The used protocol culminated in clinical success and complete periapical repair. After 12 months of root canal filling procedures, deposition of mineralized tissue and apical closure with hard tissue deposition were observed. Through the aforementioned criteria, the combination of modern imaging and the use of contempo-

rary materials contributed to adequate diagnosis, planning and treatment of this case.

Clinical Relevance

The combination of modern imaging and the use of contemporary materials contributed to adequate diagnosis, planning and treatment of this immature maxillary central incisor with an open apex and extensive periapical lesion.

Conflict of Interest

The authors have no conflict of interest to declare.

Acknowledgements

None.

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