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Photodynamic Therapy and Bioceramic in Severe External Apical Resorption: Case Report

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Abstract:
Background: *Tooth resorption is a multifactorial inflammatory process that involves the degeneration of dental tissues due to traumatic and/or infectious factors. Proper disinfection and sealing of root canals significantly influence the success of endodontic treatment. Anatomical changes in resorptions can complicate treatment, necessitating the use of photodynamic therapy in conjunction with Bio C-Repair bioceramic cement. This study aims to demonstrate the causes and treatment of external apical resorption through a case report.* ***Materials and Methods****: A 33-year-old patient presented at the Institute of Dentistry of the Americas for endodontic therapy. Radiographic examination revealed a secondary caries lesion and apical lucency in tooth 36. Computed tomography showed a hypodense region apically and laterally in the root. The initial session involved intracanal medication. Subsequently, the Xp-Endo Shaper and Xp-Endo Finisher file system was used for instrumentation, with 2% chlorhexidine gel irrigant, combined with photodynamic therapy. The canal was filled with Bio C-Repair bioceramic cement, and the pulp chamber was temporarily sealed with composite resin.* ***Results****: Three-month follow-up indicated resolution of clinical and radiographic signs.* ***Conclusion:*** *Successful treatment requires long-term follow-up.*
Keywords: *Endodontics; Root resorption; Tooth Root; Calcium Hydroxide; Laser Therapy.*

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I. Introduction

Tooth resorption is a multifactorial condition that causes damage, potentially resulting in the loss of affected teeth. Therefore, early diagnosis and proper treatment are crucial for improving prognosis and achieving treatment success[1].

Resorption involves a degenerative inflammatory process of dental tissues, which can have either a physiological or pathological origin, whether infectious or non-infectious. Physiological resorption naturally occurs in primary teeth during the eruption of permanent successors. Conversely, pathological processes have various causes, including occlusal trauma, minor traumas, orthodontic treatment, chronic inflammations originating from pulp conditions like caries or from periodontal issues, and even excessive pressure, such as in cases involving tumors or impacted teeth [1-3].

It is essential for there to be a triggering stimulus factor to initiate the resorption development process, as well as a maintenance factor that perpetuates the process. Bacterial infection is the most prevalent maintenance factor observed [1,3].

Regarding the location of resorption, it can affect any third of the root of the tooth, and there is also coronal resorption[1,3]. Resorptions can be classified as external, substitutional, external inflammatory, and internal inflammatory[2,4,5]. The process of root degeneration can progress to involve the pulp tissue, creating a communication between the pulp tissue and the periodontal or bone tissue[3].

The chosen treatment involves endodontics, whether with or without pulp necrosis associated with bacterial contamination. Additionally, it includes removing the maintenance factor and eliminating the causative stimulus to achieve stabilization of the resorptive process[3,5].

Antimicrobial Photodynamic Therapy (aPDT) is a method that has demonstrated potential as an adjunctive therapy in root canal decontamination. It utilizes a photosensitizer agent activated by a low-power light source. The dye, activated by the laser, generates reactive oxygen species (ROS) that are cytotoxic to microorganisms[6].

Several studies support the use of aPDT in conjunction with endodontic treatment for reducing intracanal microbial load[7].

To ensure treatment success, proper sealing of the root canals is crucial. It is essential to use materials that are biocompatible, meaning they do not harm tissues, and in cases of resorption, they should also be bioactive to promote repair of affected tissues[8].

For cases involving resorption, it is imperative to use calcium silicate-based cements due to their bioactivity. These cements elevate the pH of the surrounding environment and release calcium ions, which stimulate[8,9]. Moreover, these cements exhibit low toxicity, resulting in a mild inflammatory reaction and reduced postoperative pain[10].

Given the challenges encountered in treating external root resorption (ER) in endodontics, this study aims to present a clinical case of severe external apical resorption. It involves the use of photodynamic therapy in conjunction with Bio-C Repair cement to seal and repair tissue lesions adjacent to the affected dental elements.

In general, the treatment of *dens invaginatus* includes preventive sealing or filling of the invagination, in cases of vital pulp and no inflammation. If there is pulp involvement, the recommended therapeutic options are non-surgical endodontic treatment, apexification procedures or regenerative endodontics, periradicular surgery, intentional reimplantation or extraction[11].

It is essential to highlight that cases of *dens invaginatus* require an early diagnosis, which rarely occurs, considering that in the majority they are detected only when the patient presents signs and symptoms associated with extensive periradicular lesions or when accidentally observed in radiographic routine exams[11,13]. In this sense, considering the anatomical complexity and the difficulty of local treatment, it is essential for professionals to understand the different manifestations and clinical conditions when approaching cases of *dens invaginatus*, in order to apply the correct therapeutic strategies for diagnosis, planning and approach, ensuring greater predictability and the maintenance and function of the tooth involved[11].

Therefore, the objective of this study was to carry out a literature review on the clinical protocols used in *dens invaginatus* endodontic therapy, as well as the results obtained in the short and long-term postoperative follow-up.

II. Case Report

Patient D.E.D.S.S., a 33-year-old male, sought treatment at the Institute of Dentistry of the Americas (IOA) in João Pessoa-PB for endodontic care of tooth 36, identified through routine radiographic examination. Periapical radiographs of tooth 36 revealed an unsatisfactory restoration, a carious lesion with pulp involvement, a radiolucent image with irregular margins in the middle and apical thirds of the root, and shortening of the mesial roots (Figure 1). During the patient history (anamnesis), the patient reported no history of orthodontic appliance use, trauma, systemic disease, or other factors related to the condition, aside from the presence of caries visible on radiographs.

Clinical examination showed a tooth with normal coloration, no pain on palpation or percussion (negative sensitivity test), and a negative response to pulp vitality testing, indicating pulp necrosis. Grade II mobility and the presence of a parulis were also noted.

Cone Beam Computed Tomography (CBCT) was performed to assess the extent of the lesion. The CBCT scan revealed significant root resorption, particularly affecting the distal root, extending into the apical third and internal lateral root wall (Figures 2 and 3), complicating treatment planning.

Based on clinical and tomographic evaluations, the diagnosis was severe external apical resorption. The treatment plan involved using Bio C-Repair bioceramic cement (Angelus, Londrina, Brazil) exclusively for filling the mesial roots, and a 3 mm bioceramic plug combined with gutta-percha for the distal root.

Treatment was planned over two sessions to facilitate the use of intracanal medication to stimulate tissue repair. In the first session, the procedure began with the patient rinsing with 0.12% chlorhexidine gluconate for one minute. Infiltrative anesthesia was administered using 2% mepivacaine with epinephrine 1:100,000, followed by access opening with a 1014 ball drill and working length determination with a 25-mm Endo-z drill. The operative field was isolated with a rubber dam, and the preferred irrigating solution, 2% chlorhexidine gel, was used due to its low toxicity.

Instrumentation proceeded with a #15 K-file, irrigated with 2% chlorhexidine gel and saline solution. Electronic apex locator failed due to the lateral extension of the resorption, necessitating radiographic apex locator confirmation. Biomechanical preparation utilized an Xp endo-shaper #30.04 rotary file at the working length of 18mm. Final irrigation included 2% chlorhexidine gel, 17% EDTA, and sterile saline, activated with Xp Endo-Finisher #25.

The root canal was dried and filled with calcium hydroxide-based intracanal medication (UltraCal XS), followed by temporary sealing with Coltosol and Opallis flow resin, and composite resin construction (Figure 5).

During the second session, after removal of intracanal medication, further instrumentation was performed with Xp Endo-Shaper #30.04. Antimicrobial Photodynamic Therapy (aPDT) was then conducted using 0.005% Methylene Blue as the photosensitizer and a low-power laser with a wavelength of 610-660 nm. Final irrigation

protocol was repeated, followed by placement of Bio C-Repair bioceramic cement under microscopic guidance. A 3 mm plug was inserted into the distal canal, and gutta-percha cones were used for the mesial canals due to lateral extension of the resorption. Gutta-percha was condensed, and the cavity was cleaned and restored with temporary obturator, flow resin, and composite resin (Figure 7).

The patient returned for evaluation two months later, showing reduced mobility and absence of the parulis. Radiographic examination indicated decreased radiolucency, suggestive of early tissue repair (Figures 8 and 9). Long-term follow-up is necessary to assess treatment success.

III. Discussion

In the endodontic treatment of ER, computed tomography (CT) plays a crucial role in providing precise three-dimensional analysis of the tooth, allowing observation of the extent of resorption not only in the apical third but throughout the entire tooth structure. The choice of instrumentation technique is essential to achieve satisfactory decontamination of all tooth surfaces. PDT is used to enhance decontamination, while bioceramic cement is employed for proper sealing and its reparative properties. ER may progress externally, leading to irreversible damage that compromises the tooth's longevity[1].

While ER is commonly diagnosed through routine radiographs, three-dimensional evaluation with Cone Beam CT is necessary for understanding resorption anatomy and tooth element involvement without image overlap, due to its superior resolution[2,11].

Effective antimicrobial control is critical for halting ER progression, especially in cases of external apical resorption involving communication with the periodontium [2]. Removing the stimulating factor is paramount, coupled with root canal disinfection using intracanal medication and ensuring excellent canal sealing to create a conducive environment for tissue repair[3,11].

Intracanal medication aids in disinfecting untouched canal surfaces not reached during mechanical preparation. Calcium hydroxide facilitates the cessation of root resorption by raising the medium's pH, rendering it unsuitable for bacterial development, and increasing calcium ion concentration to support tissue repair[12,13]. The scientific literature confirms calcium hydroxide's biocompatibility with periradicular tissues and its role in inducing mineralized tissue [13]. Nery et al. (2021) demonstrated significant periapical lesion repair in 78.46% of cases after 11 months of postoperative endodontic follow-up[14].

aPDT serves as an adjunctive therapy for enhancing intracanal microbial reduction in endodontics, with Trindade et al. (2015) highlighting its excellent antimicrobial potential. Garcez (2015) shows that using optical fiber for irradiation generates reactive oxygen species more effectively than irradiation with equipment tips alone. [6,7].

In cases involving periodontal septal defects at risk of extraleakage, chlorhexidine is preferred for its local disinfection properties and low tissue irritation[15,16]. Studies comparing chlorhexidine with sodium hypochlorite reveal chlorhexidine's ability to provoke significantly fewer inflammatory reactions[17].

Ferreira (2019) compared ultrasonic inserts (Irrisonic, Easy Clean, XP Endo Finisher) and found all to be effective compared to conventional positive pressure irrigation techniques. Barbosa et al. (2020) emphasized the choice of obturator materials with antimicrobial properties and effective sealing to prevent bacterial proliferation from necrotic tissue debris in areas not affected by biomechanical preparation. These materials are preferred for their alkalinization and calcium ion release, reducing the risk of reinfection by bacteria resistant to irrigating solutions. [18,19].

While scientific studies confirm the efficacy of bioceramic cement, aPDT, and irrigating solution agitation, the clinical outcome remains crucial for defining treatment success through inflammation remission and tissue repair, including bone neoformation.

IV. Conclusion

With this case report study, we were able to track the case's progression and determine that the proposed therapy effectively mirrored the clinical outcomes, resulting in complete resolution of the parulid and restoration of tooth stability. Managing cases of ER presents challenges in endodontic treatment, thus the use of Bio-C Repair bioceramic cement, combined with aPDT and the Xp-Endo file system—particularly during the irrigation phase—is crucial for treating teeth affected by ER and significantly impacts prognosis. Nonetheless, long-term patient follow-up remains essential to confirm treatment success.

V. Figures

Figure 1 – Initial periapical radiograph of tooth 36.

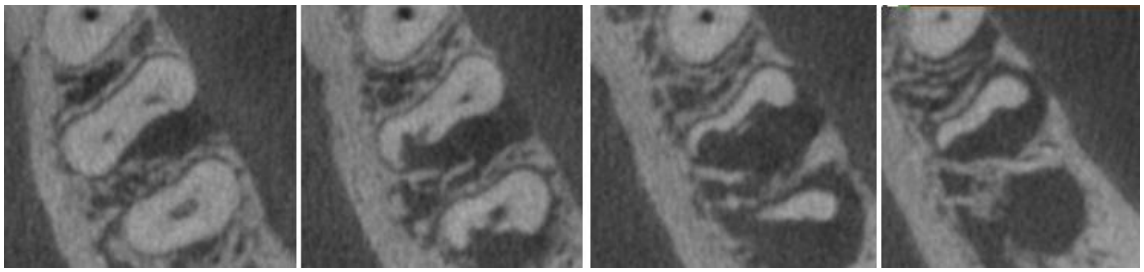

Figure 2 – Computed tomography of tooth 36.

Figure 3 – Computed tomography of tooth 36.

Figure 4 – Radiographic odontometry of tooth 36.

Figure 5 – Tooth 36 conduits filled with Ultracal.

Figure 6 – Photodynamic therapy of element 36.

Figure 7 – Final periapical radiograph of tooth 36.

Figure 8 - Periapical radiograph, 1 month after endodontic treatment.

Figure 9 – Periapical X-ray, 2 months after endodontic treatment.

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