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Pulp and Bone Regenerative Therapy Using Biomaterials and Dual Rinse 1-Hydroxyethylidene-1,1-Diphosphonic Acid in a Single Visit: A Case Report

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ABSTRACT

The use of platelet concentrates has become increasingly widespread in dentistry and regenerative medicine. Injectable platelet-rich fibrin (I-PRF) has gained attention in bone tissue engineering. Etidronic acid (HEDP), a mild chelator commercially available as "Dual Rinse® HEDP" (Medcem, Switzerland) has been introduced for endodontic use. However, to date, no reports exist on single-visit pulp and bone regenerative therapy using HEDP and I-PRF for immature permanent teeth with complete buccal bone loss following traumatic dental injury.

This case report presents a successful single-visit regenerative endodontic procedure (REP) for an immature maxillary right central incisor following trauma one year earlier. A 9-year-old female was referred with severe pain in her maxillary central incisors. The extraoral examination was within normal limits. Intraorally, maxillary right central incisor showed a complicated crown fracture, an opened pulp chamber, and a sinus tract on the labial mucosa. Clinical and radiographic examinations revealed pulp necrosis, symptomatic apical periodontitis, a large periapical lesion, and complete loss of the buccal cortical plate.

A single-visit REP was performed, the root canal was disinfected using HEDP mixed with NaOCl, and I-PRF was injected beyond the apex. At 12-month follow-up, the tooth was asymptomatic, responded to sensibility tests, and exhibited complete periapical healing with buccal bone regeneration. This case demonstrates that regenerative endodontic treatment can be successfully achieved in a single visit using HEDP and I-PRF.

Keywords: Apical periodontitis, CBCT, Dual rinse, Injectable-PRF, Pulp regeneration.

1. Introduction

Platelet-rich fibrin, a second-generation blood product, was developed to overcome the limitations associated with first-generation platelet-rich plasma (PRP). Simply, it is made mainly from the patient's blood without any additives (1).

Building upon this foundation, Miron et al. (2) introduced injectable PRF (I-PRF) by reducing centrifugation speed and time, enabling the material to remain in liquid form for 10-15 minutes before clot formation. I-PRF, prepared by centrifugation at 60 g for three minutes, enhances wound healing by modulating immune responses, promoting angiogenesis, capturing circulating stem cells, stimulating fibroblast and osteoblast proliferation, and ensuring sustained growth factor release (1,2).

Regenerative endodontic procedures (REPs), introduced over 15 years ago (3), offer an alternative to traditional apexification for immature teeth by promoting continued root development and apical closure (4). Complete root development encourages the growth of biological tissue in the root canal, improves dentinal wall thickness, and permits a favorable crown-to-root ratio, all of which may help lower the risk of root

fractures following mineral trioxide aggregate (MTA) and/or calcium hydroxide apexification procedures (5). The success of REPs is significantly influenced by the biological balance between the effective removal of pre-operative root canal infections, the survival of stem cells, and the bioactive qualities of root dentin (6).

Similar to the apexification technique, the use of inter-appointment medicaments in REPs prevented a one-visit procedure, thereby increasing the risk of canal re-infection between appointments and compromising stem cell survival (7). Only a small number of effective single-visit regenerative endodontic procedures that managed the intracanal infection with irrigants solutions alone have been reported (8,9).

Effective root canal treatment involves chemo-mechanical debridement to disinfect the root canals to a level conducive to healing (10). Endodontics has employed several anti-microbial medications to disinfect root canals. Therefore, the gold standard for effective disinfection and smear layer removal was to use sodium hypochlorite (NaOCl) followed by a chelating agent, like ethylenediaminetetraacetic acid (EDTA). The mild chelator, hydroxyethylidene diphosphonic acid (HEDP), which has short-term compatibility with NaOCl (11), has been proposed as an alternative to address the limitations associated with EDTA use. Dual rinse HEDP is based on sodium etidronate, and its chemistry is based on the addition of the mild chelator HEDP to NaOCl immediately before clinical use. This combination provides both chelating and proteolytic effects, making it the first HEDP material recommended for use in root canal therapy.

This report presents a novel approach combining HEDP and I-PRF in a single-visit regenerative endodontic treatment of a traumatized immature permanent incisor with severe periapical pathology and buccal bone loss.

2. Case Report

A 9-year-old female patient was referred for management of a traumatized maxillary right central incisor (11). She reported severe localized pain associated with tooth #11 and a recent history of facial swelling, which had subsided following a six-day course of amoxicillin (500 mg) prescribed by her dentist. A pulpotomy and temporary restoration had subsequently been performed.

Extra-oral clinical examination revealed no abnormal findings. Intra-orally, tooth # 11 revealed a complicated crown fracture with previously accessed pulp chamber. The tooth was restored with Cavit (3M ESPE, St Paul, MN). A sinus tract was observed on the labial mucosa at the level of the coronal third of the root. Clinical examination revealed severe tenderness to percussion and palpation, with a negative response to sensibility testing.

2.1 Radiographic and CBCT Findings

Periapical radiographs and CBCT imaging revealed an extensive periapical radio-lucency with incomplete root formation and complete loss of buccal bone plate. Based on these findings, a diagnosis of pulp necrosis with symptomatic apical periodontitis was made. After discussing the possible treatment options, the patient's parents approved the regenerative endodontics therapy and provided informed written consent.

2.2 Clinical Procedure

The patient was anesthetized with 3% mepivacaine (Scadonest Septodont; Cedex, France) without a vaso-constrictor. The tooth was isolated with a rubber dam, and the temporary filling was removed. The entire procedure was performed under a surgical operating microscope Zumax (Zumax Medical Co., Ltd. Suzhou, China). The access was refined using a coated ultrasonic tip, E3D (Guilin Woodpecker Medical Instrument Co., Ltd., Guilin, China). Bleeding and exudate were observed. A total of 5 ml of saline was used to manage the exudate and the bleeding from the root canal. The working length (WL) was determined by placing a size #70 hand K-file to the end of the root canal under magnification and was confirmed with a periapical radiograph.

The root canal was irrigated with 10ml of Dual Rinse HEDP solution. According to the manufacturer's instructions (11), a Dual Rinse HEDP-based solution was made by mixing 10 mL of 3% NaOCl with one capsule of Dual Rinse etidronic acid (HEDP) powder (Medcem, GmbH, Vienna, Austria) using a syringe fitted with a 28-gauge side vented needle. The irrigant was activated using ultrasonic tip E4D for 30 seconds (Guilin Woodpecker Medical Instrument Co., Ltd., Guilin, China). The needle was positioned 2 mm short of the working length throughout the procedure to ensure safe and effective delivery of the irrigant. Then, the root canal was dried using sterile paper points.

Irritation of apical tissues beyond the apex was

performed using a Hedstrom file to induce bleeding into the canal. I-PRF (venous blood from the patient centrifuged at 800 rpm for 3 min) was obtained from the test tube in a syringe and injected beyond the apex (12). Hemostasis was promoted with a sterile cotton pellet at the level of the cemenenamel junction, 5mm of MTA Angelus (Angelus Industry, Londrina-PR, Brazil) was placed over the formed blood clot to seal the coronal portion of the root canal, and a radiograph was taken (Figure 1). RelyX™ Unicem Self-Adhesive Universal Resin Cement (3M ESPE, Seefeld, Germany) was used to cover the MTA plug, and at the same appointment, the tooth was restored with composite resin.

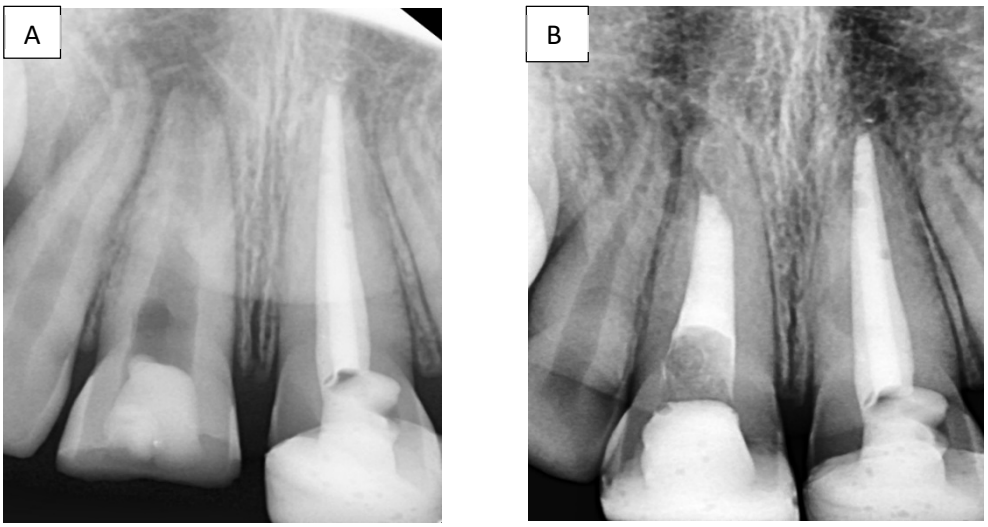

Figure 1: Treatment of traumatized maxillary right central incisor. (A) Pre-operative radiograph of the maxillary right central incisor (B) Twelve-month radiographic follow-up demonstrating the resolution of the periapical lesion with complete apical closure of the root

Follow-up visits were recommended at 6-month and 12-month intervals. No clinical signs of infection (pain, swelling, sinus tract) or tooth discoloration was reported at any of these control visits. The tooth showed no mobility, and the probing depth was within normal limits.

At the 12-month follow-up, the primary outcome-based clinical and radiographic examinations revealed that the tooth was asymptomatic, with complete resolution of periapical pathosis and full regeneration of the buccal bone. The secondary outcome included root elongation and increased thickening of the root walls (Figure 2).

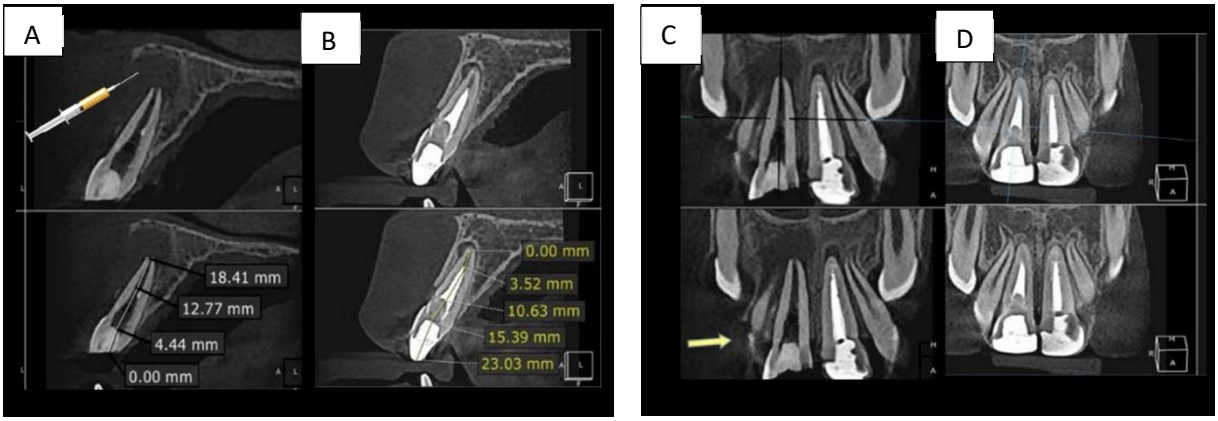

Figure 2: Treatment of traumatized maxillary right central incisor. (A) Pre-operative radiograph of maxillary right central incisor in sagittal view. (B) Twelve-month radiographic follow-up demonstrating the resolution of periapical lesion. (C) Pre-operative radiograph of maxillary right central incisor in coronal view. (D) 12-month follow-up radiograph showing a complete apical closure of the root

The tertiary outcome showed that the tooth responded to sensibility tests. It was concluded that regenerative endodontic treatment can be successfully performed in a single visit.

3. Discussion

The successful regeneration observed in this case highlights the potential of using injectable platelet-rich fibrin (I-PRF) and Dual Rinse® HEDP for single-visit regenerative endodontic procedures (REPs) in immature teeth with severe periapical pathology.

Platelet-rich fibrin (PRF) scaffolds have demonstrated promising outcomes in guided endodontic repair across several clinical studies (13). Extra-cellular glycoprotein fibronectin is the main component of I-PRF. Fibronectin has a high molecular weight. Additionally, fibronectin, when applied to root surfaces, promotes cellular migration and proliferation from supra-crestal tissues to the periodontal ligaments, facilitating cellular growth (14). Compared to PRP, I-PRF has superior biological properties, including enhanced cytokine entrapment and greater cellular motility. It also demonstrates a higher capacity to stimulate regeneration due to its increased release of growth factors. It also forms a small fibrin clot, which enables it to act as a dynamic gel. Importantly, the preparation process is simple and cost-effective. I-PRF also plays a critical role in the sustained release of growth factors throughout 10 to 12 days, facilitating more effective tissue regeneration (2,15).

For immature necrotic teeth, the clinical effectiveness of RET fundamentally depends on a disinfection strategy that aims to eliminate the bacterial bio-film attached to the root canal walls, repair the periapical tissues, or prevent apical periodontitis (16). The most crucial irrigating solution in root canal therapy is NaOCl, which is utilized in concentrations ranging from 0.5 to 6% (10). Ethylenediaminetetraacetic acid (EDTA), has been generally advised as a penultimate irrigating solution to eliminate the inorganic part of the smear layer formed during root canal instrumentation (17). Using EDTA and NaOCl in combination is avoidable during root canal therapy, as this could reduce the tissue-dissolving and antibacterial properties of the latter. The sequential and continuous use of chelation can cause inter-tubular and peritubular dentine erosion, which would lower the dentine's flexural strength. The continuous chelation concept (11), a dual-action endodontic solution that can be used as a single irrigant and during the instrumentation stage of the root canal, is made by combining NaOCl with a soft chelator HEDP. Gram-positive, facultatively anaerobic *Enterococcus faecalis* is mainly associated with asymptomatic primary endodontic infections and failed endodontic cases (18). These findings are consistent with those reported by Castagnola et al. (19) and Arias-Moliz et al. (20), who assessed the anti-bacterial activity of 2.5% NaOCl and 2.5% NaOCl/9% HEBP and reported that both solutions killed 100% of the *E. faecalis* bio-films. Since the absence of inter-appointment medications, like TAP/DAP or $Ca(OH)_2$, reduces the risk of discoloration and bacterial re-growth within the root canal system, the biological principles of single-visit REPs are based on the anti-bio-film effect of irrigant solution to manage the intra-canal infection of immature necrotic teeth, improving patient compliance (21).

The present case demonstrated complete periapical healing, buccal bone regeneration, continued root development, and recovery of pulp sensibility, supporting the biological and clinical feasibility of single-visit regenerative endodontic therapy using Dual Rinse® HEDP and I-PRF. However, while the results are encouraging, larger-scale clinical studies and randomized controlled trials with long-term follow-up are necessary to validate and standardize this approach.

4. Conclusions

This case report demonstrates that single-visit regenerative endodontic treatment using Dual Rinse® HEDP as a root canal irrigant, combined with injectable platelet-rich fibrin (I-PRF), can achieve successful periapical healing, buccal bone regeneration, and recovery of pulp sensibility in immature necrotic teeth. The approach eliminates the need for inter-appointment medicaments, potentially reducing treatment time and improving patient compliance. Furthermore, a clinical randomized controlled trial with long-term follow-up examinations is needed to establish the efficacy of single-visit regenerative endodontic treatment using HEDP Dual Rinse as a root canal irrigant.

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