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Advances in Pharmacology and Clinical Trials
ISSN: 2474-9214

A Comparative Evaluation of Biological Scaffold in Regenerative Endodontic Treatment of Immature Non-Vital Permanent Teeth

Hammouda L* and Douki N

Faculty of Dental Medicine, University of Monastir, Tunisia

***Corresponding author:** Latifa Hammouda, Faculty of Dental Medicine of Monastir, Endodontic Resident, Dental Medicine Department of the Sahloul Hospital, Sousse, Tunisia, Email: Hamoudalatifa1994@gmail.com

Short Communication

Volume 8 Issue 4

Received Date: October 26, 2023

Published Date: December 13, 2023

DOI: 10.23880/apct-16000224

Abstract

Endodontic treatments techniques for immature necrotic teeth include: surgical endodontics, apexification, and single-visit MTA plug. Regenerative endodontic therapy (RET) is a newer concept that involves restoring the pulp-dentin complex in an infected tooth with an open apex. The aims of this paper were to evaluate RET of immature permanent teeth using biological scaffold and the distinctions between them, with a focus on their ease of manipulation and regenerative potential.

Keywords: Dental Pulp Necrosis; Regenerative Endodontics Therapy; Pulp Regeneration; Blood Clot; Platelet-Rich Fibrin; Platelet-Rich Plasma; Injectable Platelet-Rich Fibrin; Immature Permanent Teeth

Short Communication

Dental pulp necrosis in immature permanent teeth, a common health problem, caused by dental caries or trauma leads to the cessation of root development, characterized by short roots with thin walls and an open apex. The conventional treatment is apexification, which consists of the removal of all the dental pulp and the filling of the canal space with calcium hydroxide or a MTA apical plug. This therapy aims to ensure the formation of an apical barrier thanks to the biological properties of these materials and the canal obturation. This treatment induces a weakening of the tooth and a greater susceptibility to endodontic infections [1,2]. A second apexification technique has been proposed: pulp revascularization, which consists of sealing the canal with a blood clot obtained by induced bleeding. However, this technique also has some limitations, namely the difficulty of obtaining bleeding and especially the lack of growth factors in the blood clot necessary for the continuation of root formation and apical maturation. Currently, in vitro and clinical research is investigating the possibilities of pulp regeneration using tissue engineering. This research has improved the previous technique by adding a platelet-rich concentrate or fibrin-rich concentrate in order to increase the concentration of growth factors as well as the number of regenerative stem cells in the dental canal to ensure the continuity of root formation and apical closure [1-3]. The aims of this paper were to evaluate RET of immature permanent teeth using biological scaffold and the distinctions between them, with a focus on their ease of manipulation and regenerative potential.

RET is a biologically-based procedure designed to physiologically replace damaged tooth structures, including dentin and root structures, as well as cells of the pulp-dentin complex [4]. Many previous studies have explored various scaffolds for RET in immature permanent teeth with pulp necrosis [1,3]. The scaffold must provide the right location for stem cells and regulate their differentiation, proliferation, and metabolism by releasing growth factors. Different protocols have been proposed for regenerative endodontic treatment (RET), with the main differences being in the disinfection technique used, the intracanal medication, the scaffold systems, and the coronal filling materials. To reduce this variability, the American Association of Endodontists (2013) and the European Society of Endodontology (2016) developed evidence-based recommended protocols. These guidelines have helped to reduce some of the differences in RET steps, such as the use of EDTA and sodium hypochlorite. However, variations in terms of intracanal medication, sealing material, and assessment tools still exist due to the lack of high-quality evidence [5-7]. Studies showed that the most likely outcome of RET in immature teeth is an increase in root thickness rather than length. This is thought to be due to injury to the Hertwig's epithelial root sheath (HERS) cells, which are responsible for root length growth. Histological studies revealed that root elongation and thickening after RET is characterized by the deposition of cementum-like tissue at the apex and lateral walls of the canal, as well as scattered bone-like tissue in the canal. Some complications that can occur after RET in immature permanent non-vital teeth include pulp canal calcification and ankylosis between the intracanal hard tissue and the apical bone [8]. However, these complications are uncommon according to studies [4-7]. Platelet-rich plasma (PRP), first-generation platelet concentrate, has been proposed as a better scaffold system for regenerative endodontic treatment (RET) due to its high concentration of platelets and important growth factors. However, extensive research on PRP scaffolds over the past decade has shown no significant improvement in clinical and radiographic outcomes compared to blood clots (BC) [9,10]. However, periapical healing sizes after 6 months were smaller in PRP-treated teeth than in either PRF- or BC-treated teeth, suggesting that PRP provides better and more rapid periapical wound healing than PRF or BC. PRP has the consistency of a liquid, enabling it to reach the periapex without any impedance. By contrast, PRF has a gel-like consistency, delivering the maximum amount of growth factors to hasten the wound healing process. Moreover, teeth treated with platelet concentrates achieved better apex closure (PRF, PRP), root lengthening and thickening of the dentin walls than teeth treated with blood clots, although these differences were not statistically significant [11]. PRP is a natural scaffold that eliminates the risk of cross-infection and immunogenicity, but it is not 100% autologous. PRF was introduced to overcome this limitation of PRP and also to enhance the release of growth factors and leukocytes [1,9].

Simonpieri, et al. [11] revealed that PRF acts as a biological connector that holds bone particles together, protects grafted biomaterials, allows cells to move for new blood vessel formation (neoangiogenesis), promotes healing by releasing cytokines, and fights infection [11]. Ulusoy, et al. [4] compared the use of a blood clot, platelet-rich plasma (PRP), PRF, and platelet pellets as scaffolds for regenerative endodontic therapy (RE therapy) and found that the platelet derivatives resulted in a higher rate and longer exposure to growth factors with less chance of obliteration of the root canal space [4].

With a better understanding of the use of autologous platelet concentrates and their role in healing, newer variants of PRF have been developed. Studies have shown that a slight increase in centrifugation can improve the quality and yield of PRF [12]. Studies have shown that slightly increasing centrifugation time and reducing centrifugation speed produces advanced platelet-rich fibrin (A-PRF), a variant of standard PRF with greater regenerative potential. Jayadevan, et al. revealed that A-PRF is a better choice than PRF for root thickness gain in immature teeth, as A-PRF showed greater root thickness gain than PRF, while PRF showed greater root length gain [12].

On the other hand, the solid-state of PRF limits its applications. I-PRF is a new liquid blood derivative developed in 2014 using the low-speed centrifugation concept. It contains high concentrations of platelets, leukocytes, and growth factors, and has been shown to promote tissue regeneration in a variety of settings, including bone, gum tissue, and nerve tissue. Compared to PRF, i-PRF has shown superior results in terms of bone regeneration, treatment of gum recession defects, and elimination of endodontic infection. However, more high-quality evidence is needed to determine whether i-PRF is an optimal scaffold for regenerative endodontic treatment [13,14].

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