

Regeneration and repair in endodontics

Deeksha Pharasi

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ABSTRACT

The most typical cause of the pulp-periapical disease is caries. Because the infected or non-infected necrotic pulp tissue in the root canal system is not accessible to the host's innate and adaptive immune defense mechanisms and antimicrobial agents, root canal therapy is the only option for treatment when the pulp tissue involved in caries becomes irreversibly inflamed and progresses to necrosis. Therefore, pulpectomy is required to remove the necrotic pulp tissue from the canal space, whether it is diseased or not. For many years, endodontists

have been searching for biologically based therapy methods that could encourage regeneration or repair of the dentin-pulp complex that has been damaged by trauma or infection. The dental stem cells that can regenerate the dentin-pulp complex were found after a protracted, exhaustive search *in vitro* laboratory and *in vivo* preclinical animal tests. As a result, the biological idea of "regenerative endodontics" evolved, highlighting a paradigm shift in the way clinical endodontics treats young permanent teeth with necrotic pulps

Key Words: Endodontics; Stem cells; Periapical bleeding; Root canal

INTRODUCTION

The most typical cause of the pulp-periapical disease is caries. The host's innate and adaptive immune defense mechanisms and antimicrobial agents cannot reach the infected necrotic pulp in the root canal system when the pulp tissue involved in caries becomes irreversibly inflamed and progresses to necrotic, leaving root canal therapy as the only option for treatment. Therefore, a pulpectomy is required to remove the infected necrotic pulp tissue from the canal space in order to stop the progression or persistence of apical periodontitis. The cleansed root canal space should not be left empty and should be filled with a biocompatible material to avoid reinfection of the canal space for many years. This treatment method was the most acceptable for teeth with infected or non-infected necrotic pulps. The root canal infill was anticipated to stop coronal leaking, slow down bacterial invasion into the periapical tissues, and possibly ensnare bacteria already present in the canal space. Unfortunately, not all endodontically treated teeth may have these desired results from root canal fillings [1].

REVASCULARIZATION

In studies of pulpal wound healing following the replantation of immature permanent teeth, the term "revascularization" was employed [2,3]. The word "revascularization" was first used by Iwaya and collaborators in their endodontic treatment of an immature permanent tooth with apical periodontitis and a sinus tract. Treatment methods included irrigation with sodium hypochlorite and administration of antibiotic paste (ciprofloxacin, metronidazole) directly into the canal without mechanical debridement. Clinical symptoms were eliminated, and apical periodontitis was resolved as a result of the treatment [4].

REGENERATIVE ENDODONTICS

Additionally, ongoing root growth and radiographic thickening of the canal walls were noted [4]. Theoretically, some live pulp tissue that may have remained in the tooth that had been clinically determined to have devitalized and infected pulp was responsible for the regeneration of the dentin-pulp complex [4]. Because stem cells from the apical papilla were demonstrated to be capable of developing into odontoblasts and creating root dentin, it was also hypothesized that continued root development may have resulted from the survival of the apical papilla in apical periodontitis [5]. Revascularization procedures have been carried out in numerous human juvenile permanent teeth with necrotic pulps and apical periodontitis since the publication of Iwaya and collaborators' study [4].

PERIAPICAL BLEEDING

Along with growth factors, blood clots, and mesenchymal stem cells, periapical bleeding also causes the innate and adaptive immune defense system's humoral (complement proteins, immunoglobulins, chemotaxis, and antibacterial peptides) and cellular (polymorphonuclear leukocytes, macrophages) components to enter the canal space. The blood contains these immune cells and bioactive peptides [6]. Immunoglobulins can coat and locate bacteria, and complement components like C3b can opsonize bacteria. This allows for easier phagocytosis by activating polymorphonuclear leukocytes and macrophages via C3b and Fc receptors on these phagocytes. Additionally, mesenchymal stem cells can secrete the antimicrobial peptide LL-37, activate genes that aid in phagocytosis and the killing of bacteria, boost the antibacterial activity of immune cells, and

Department of Biotechnology, Graphic Era University, Dehradun, India

Correspondence: Deeksha Pharasi, Department of Biotechnology, Graphic Era University, Dehradun, India, E-mail: deekshapharasi@gmail.com
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release significant amounts of the cytokines IL-6, IL-8, and MIF (macrophage migration inhibitory factor) to draw in and activate macrophages and polymorphonuclear leukocytes [6-8]. The possibility of LL-37 aiding in the regeneration of the dentin-pulp complex in regenerative endodontics was also raised [9]. Therefore, during regenerative endodontic therapy, inducing periapical bleeding into the canal space may improve antimicrobial clearance in the canal space. Furthermore, it cannot be ruled out that after regenerative endodontic therapy, any remaining bacteria in the canal area may be eliminated by the immunological defense systems of the restored essential tissue. The remarkable success rate of juvenile permanent teeth with diseased pulps and apical periodontitis following regenerative endodontic therapy lends support to this argument [10].

ROOT CANAL FILLINGS

Remaining bacteria in the canal space after root canal disinfection is a problem in regenerative endodontic therapy for immature or mature permanent teeth with necrotic pulps because germs may proliferate there without a root filling. Due to the anatomic intricacy of the root canal system, modern root canal infection prevention procedures, such as mechanical instrumentation, sodium hypochlorite irrigation, and intra-canal calcium hydroxide treatment, are unable to completely eradicate all germs [11,12]. The most common intra-canal drug used in root canal therapy, calcium hydroxide, has limitations when it comes to removing intra-canal germs since dentin and hydroxylapatite have an inhibitory influence on calcium hydroxide's anti-microbial action [13,14]. How much root canal filling affects the outcome of non-surgical root canal therapy is unknown. When bacteriologic cultures of the canals before root-filling were negative, Sjogren and colleagues demonstrated clinically in human teeth with apical periodontitis that the success rate of root canal therapy was 94% [15]. The success rate was 68% if bacteriologic cultures were positive, in contrast. Fabricius and colleagues recently demonstrated in monkey models that when bacteria persisted following endodontic treatment, 79% of root canals displayed unhealed periapical lesions, as opposed to 28% in cases when no bacteria were detected [16]. These studies highlight the fact that preventing root canal infections matters more than root filling.

CONCLUSION

By increasing innate and adaptive immune defense mechanisms to remove irritants and establish a favorable milieu suitable for tissue repair and/or regeneration to occur, the goal of illness treatment is to aid the host's natural wound healing processes. Apical periodontitis of developing and fully developed permanent teeth is primarily caused by infection. Therefore, the tissue should be able to heal if the infection is successfully controlled. Traditional root canal therapy is mechanically and physically based and is used on both immature and mature permanent teeth with necrotic pulps. The operations entail cleaning the root canals, removing the infected necrotic pulp, and filling the canal space with biocompatible foreign material.

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