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# Regenerative Endodontics in Pedodontics-A Case Report

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## Abstract

The vitality of dentin–pulp complex is fundamental to the life of the tooth and is a priority for targeting clinical management strategies. One novel approach to restore tooth structure is based on biology: regenerative endodontic procedure by application of tissue engineering. Regenerative endodontics is an exciting new concept that seeks to apply the advances in tissue engineering to the regeneration of the pulp–dentin complex. The basic logic behind this approach is that patient-specific tissue-derived cell populations can be used to functionally replace integral tooth tissues. The development of such "test tube teeth" requires precise regulation of the regenerative events to achieve proper tooth size and shape, as well as the development of new technologies to facilitate these processes. This article provides a general review of literature and a case report on the concept of revascularisation and its application in endodontics, providing an insight into the new developmental approaches on the horizon.

**Keywords:** Endodontics, Pulp–Dentin, Stem Cells, Tissue

## Introduction

Regenerative endodontic procedures can be defined as biologically based procedures designed to replace damaged structures, including dentin and root structures, as well as cells of the pulp–dentin complex.[1,2] The objectives of regenerative endodontic procedures are to regenerate pulp-like tissue, ideally, increased mobility. The treatment of the immature nonvital anterior tooth with apical pathosis presents several treatment challenges.[5] The mechanical cleaning and shaping of a tooth with blunderbuss apex are difficult if not impossible. The thin, fragile lateral dentinal walls can fracture during mechanical filing or during lateral the pulp–dentin complex; regenerate damaged coronal dentin, such as following a carious exposure; and regenerate resorbed root and cervical or apical dentin. Regenerative endodontics comprises research in adult stem cells, growth factors, organ-tissue culture, and tissue engineering materials.[3] Pulp necrosis of an immature permanent tooth from the trauma or caries arrests further tooth development. As the root development takes a long time, an incompletely formed apex is one of the most common features seen in traumatized teeth. The loss of pulpal vitality before completion of dentin deposition leaves a weak root more prone to fracture as a result of the thin dentinal walls.[4] It will also lead to a poor crown-to-root ratio, with possible periodontal breakdown as a result of condensation.[6] Another classic option for such teeth includes endodontic surgery to seal the wide apex by retrograde means. However, this invasive procedure has its own disadvantages as surgical complications. Another drawback is the compromised crown-root ratio which further weakens the already fragile root. Apexification has some chances of success, but it also has many limitations as multiple visits during a long period of time (6–24 months), porous barrier, and inadequate seal. Even some reports have shown that long-term calcium hydroxide ($Ca(OH)_2$) therapy may leave the thin walls even more prone to fracture.[7] An alternative to traditional apexification is to place an artificial barrier at the apex using materials as mineral trioxide aggregate (MTA). However, even MTA does not strengthen the remaining root structure, so tooth stays fracture prone. Another treatment advocated for such weakened roots is the root reinforcement using composite resins, but they may limit the possibility of root canal retreatment in future if need arises.[5]

Hence, the ideal treatment to obtain further root development and thickening of dentinal walls in an immature tooth with apical periodontitis would be revascularization that is to reestablish the vitality in a nonvital tooth to allow repair and regeneration of pulp dentin complex. The term “revascularization” has been used for the reestablishment of vascularity in the pulp space after traumatic injuries. However in this situation, there is generation of tissues, such as cementum, periodontal ligament, bone, and dentin, or regeneration of pulp occurs rather than just the generation of vasculature in the canal space. This revascularization restores functional properties of the tooth, and induces root development for immature teeth.[8] Thus, using the term revascularization for regeneration of a pulp-dentin complex has been questioned and better option would be maturation of the root. The research on the regeneration of a pulp–dentin complex has a long history. It was introduced by Ostby in 1961,[9] and in 1966, Rule and Winter[10] documented root development and apical barrier formation in cases of pulpal necrosis in children. In 1971, Nygaard-Ostby and Hjortdal[11] performed studies that can be considered the forerunner of pulpal regeneration. The results of these studies were variable. However, the materials and instruments available 40–50 years ago were probably not sufficient and adequate. The current research in regenerative endodontics uses greatly improved materials, instruments, and medications and applies many principles from the fields of trauma research and tissue engineering; hence, it could be possible to effectively disinfect an infected pulp, artificially place a scaffold, and then effectively seal the access cavity to resist subsequent infection.[12,13] Occasional cases of regeneration of apical tissues after traumatic avulsion and replantation led to the search for the possibility of regeneration of the whole pulp tissue in a necrotic, infected tooth.[3] After reimplantation of an avulsed immature tooth, a unique set of circumstances exists that allows regeneration to take place

1. The young tooth has an open apex and is short, which allows new tissue to grow into the pulp space relatively quickly



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2. The pulp is necrotic but usually not infected, so it will act as a matrix into which the tissue can grow
3. In addition, the fact that, in most cases, the crown of the tooth is intact ensures that bacterial penetration into the pulp space through cracks and defects will be a slow process.[14] Thus, the race between the new tissue and infection of the pulp space favors the new tissue and it was hypothesized that once the canal infection is controlled, it resembles the avulsed tooth that has a necrotic but sterile pulp space. Hence finally, the rationale of revascularization is that if a sterile tissue matrix is provided in which new cells can grow, and pulp vitality can be reestablished.[15] There were several factors that helped the immature teeth achieve continued root development. First, the immature tooth has a wide root canal, an open apex, and a short root. In the ideal case, there is pulp necrosis with an immature apex opening more than 1 mm in a mesiodistal dimension radiographically.[16] Murray et al.[3] have even suggested that the revascularization of necrotic pulp in a tooth with a closed apex may require instrumentation to approximately 1–2 mm in apical diameter to allow systemic bleeding into the root canal system. Hence, the new tissue has easy access to the root canal system and a relatively short distance for proliferation to reach the coronal pulp horns. Second, these patients are young (8–13 years old) and so have greater healing capacities or stem cell regenerative potential.[17] Third, all root canals of the diseased teeth were treated as conservatively as possible. No instrumentation was done in the root canals, whereas all of the studies used sodium hypochlorite (NaOCl) as an irrigant. Minimum instrumentation and disturbance of the root canal system also preserved more viable pulp tissues.[18,19] Further, both Ca (OH) 2 paste and combinations of multiple antibiotics have been used, but the results are variable. Finally, the formation of a blood clot might serve as a protein scaffold, permitting three-dimensional ingrowth of tissue. It is suggested that the all these mentioned favorable factors finally lead to successful clinical outcomes.[20]

**Case Report**

A 9-year-old male patient reported with the chief complaint of pain in the upper front teeth region for the past 20 days. Parents revealed that there was a history of trauma to the upper front teeth region 1 year back. Dental, medical, and familial history was noncontributory. Intraoral examination revealed Ellis Class IV fracture in the left maxillary central incisor,[20] and the tooth was tender on vertical percussion. Intraoral periapical radiograph of the maxillary anterior region [Figure 1] revealed slight irregular periapical radiolucency (approximately 2 mm in diameter) in relation to 21. Both maxillary central incisors were present with blunderbuss canal, and apical closure was still incomplete in 11 and 21. Both the teeth were found to be nonresponsive for pulp vitality testing by heat test and Electric Pulp Tester (EPT) (Parkell Digitest 2). Informed consent was obtained from his parents for regenerative endodontic treatment. An access cavity preparation was performed under local anesthesia with 2% lidocaine (Warren Lignox, India) and rubber dam isolation (Coltene Rubber Dam Kit Hygenic, Coltene-whaledent). On the first visit, access cavity was prepared in 21 under rubber dam isolation, and the canals were thoroughly irrigated with 1.5%, 20 ml NaOCl (Chemdent, India) for 5 min using side-vented irrigation needle (Prima-Dental, India) followed by 5 min irrigation with normal saline 20 ml. For proper disinfection of the canal, the tip of the needle was placed at the apical third



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of the root. No biomechanical preparation was done at the first visit to avoid any harm to viable tissue such as stem cells. Paper points were used to thoroughly dry the canals and a paste of tri antibiotic paste mixture (minocycline, metronidazole, and ciprofloxacin) in 1:1:1 concentration mixed in normal saline vehicle was placed in the canals with sterile paper points below the cementoenamel junction. The access cavity was sealed with a layer of Zinc Oxide Eugenol Cement (Cavit, Ammdent, India) followed by a second layer of Type II Glass Ionomer Cement (Fuji II, GC). This dressing was kept for 21 days. During the second appointment, there was no tenderness on percussion and the absence of mobility on both vertical and horizontal directions in 21. Intraoral periapical radiograph of 21 [Figure 2] revealed decreased periapical radiolucency. The access cavity was reopened and again the root canal was thoroughly irrigated with 1.5%, 20 ml/canal NaOCl for 5 min with side-vented irrigation needle and normal saline 20 ml/canal for 5 min. A sterile 15 No. K-File was introduced within the canal and was placed beyond the apex for induction of bleeding and was kept for 10 min for the blood clot formation. White MTA (ProRoot MTA, Denstply) of 3–4 mm thickness was placed coronally and the access cavity was closed with cotton and cavit. One week later, the patient returned asymptomatic and the cavit and cotton pellet were replaced with a bonded resin restoration. The patient was advised for recall visit after 1 month, 3 month, 6 month, 9 month, and 1 year for review. In follow-up visits, the teeth showed a negative response to percussion and palpation tests but did not respond positively to heat or an EPT. Radiograph revealed continued thickening of the dentinal walls, root lengthening, regression of the periapical lesion, and apical closure. On 1-year follow up, the tooth was asymptomatic and radiograph showed root-end closure in relation to #21 [Figure 3]

Figure 1: Preoperative intra-oral periapical radiograph

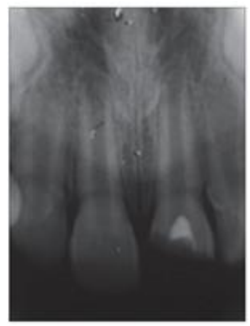

Figure 2: Postoperative intra-oral periapical radiograph

Figure 3: 1 year follow up radiograph

**Conclusion**

The complete restoration of physiologic, structural, and mechanical integrity of native pulp–dentin complex is ultimate goal of endodontic treatment. Till date, several approaches have been proposed to achieve this goal. For a new approach to gain acceptance, it should either produce better results or at least equivalent results in lesser time and at a lower cost. Consequently, the road to tissue engineering is not smooth. The ethical and moral concerns regarding the use of embryonic stem cells, challenges in identification of stem cells that can be



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maintained and expanded in culture, and slower rate of human tooth embryogenesis are the barriers to be overcome for the successful clinical application of concepts of tissue engineering in endodontics. Areas that might have application in development of regenerative endodontic techniques are (a) root canal revascularization via blood clotting, (b) postnatal stem cell therapy, (c) pulp implantation, (d) scaffold implantation, (e) injectable scaffold delivery, (f) three-dimensional cell printing, and (g) gene delivery. The future development of regenerative endodontic procedures will require a comprehensive research program directed at each component and their clinical application. The regenerative therapy will revolutionize the future endodontics with synergistic confluence of advances in signaling pathways underlying morphogenesis and lineage of stem cells by morphogens such as bone morphogenetic proteins, transforming growth factor-beta, and synthetic scaffolds.

Declaration of patient consent the authors certify that they have obtained all appropriate patient consent forms. In the form, the patient’s parents have given their consent for his images and other clinical information to be reported in the journal. The patient’s parents understand that name and initials will not be published and due efforts will be made to conceal identity, but anonymity cannot be guaranteed.

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