

# Pulp Revascularization of Immature permanent teeth: A Systematic Review

Nilotpol Kashyap<sup>1\*</sup>, Amit Tandulkar<sup>2</sup>, Chaitainya Metkar<sup>3</sup>, Brij Kumar<sup>4</sup>

<sup>1</sup>Professor, Department of Pedodontics and Preventive Dentistry, Rungta College of Dental Sciences & Research, Bhilai.

<sup>2</sup>Post Graduate Student, Department of Pedodontics and Preventive Dentistry, Rungta College of Dental Sciences & Research, Bhilai.

<sup>3</sup>Senior Lecturer, Department of Endodontics, Swargiya Dadasaheb Kalmegh Smruti Dental College and Hospital, Nagpur.

<sup>4</sup>Reader, Department of Pedodontics and Preventive Dentistry, Rungta College of Dental Sciences & Research, Bhilai

**\*Corresponding Author:** Nilotpol Kashyap, Professor, Department of Pedodontics and Preventive Dentistry, Rungta College of Dental Sciences & Research, Bhilai.

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## Abstract

Dental pulp has capacity to regenerate under certain conditions. Due to recent advances in dental materials and techniques newer methods of regeneration of the pulp tissue are replacing traditional method of pulp therapy. Pulp revascularization play a vital role in apical closure of the root. This article is an attempt to review the procedure of revascularization in tooth as well as materials used.

**Keywords:** Pulp Revascularization, Calcium Hydroxide, Triple Antibiotic Paste, EDTA.

## Introduction

Pulp revascularization is dependent on the ability of residual pulp and apical and periodontal stem cells to differentiate. These cells have the potential to generate a highly vascularized and a conjunctive rich living tissue. These stem cells have the ability to colonized the available pulp space and subsequently differentiate in to newly formed odontoblast which induces dentin formation [1].

There are generally 2 types of stem cells

- Embryonic stem cells
- Adults stem cells

With respect to pulp vascularization, mature stem cells are of more interest. These cells are found in many sites of the dental elements i.e., in the pulp, in the apical papilla and in the periodontal ligament. These cells are capable of inducing dentin and pulp regeneration if they differentiate in to the appropriate cells.

Revascularization is new way of treating immature necrotic permanent teeth. After treatment, revascularization provides a vital tooth that would be able to complete its root maturation. Until the recent past, necrotic immature permanent teeth where treated apexification procedure using calcium

hydroxide or MTA to produce an apical calcified barrier. Both methods of apexification and revascularization has been found to be effective in narrowing of the apical foramen of the immature tooth. However, pulp revascularization allows the stimulation of the apical development as well as root maturation.

## Indications Of Revascularization [2]

The presence of deep caries or trauma inducing a stoppage in the development root canal of a tooth.

- In necrotic immature permanent teeth.
- Immature teeth with large open apex and short roots.

## Types Of Pulp Revascularization Based on Disinfection

- Calcium hydroxide
- Triple antibiotic paste

The success of pulp revascularization depends on 3 elements

Root canal disinfection

- The presence of scaffold (blood clot).
- Hermetic coronary filling.

## Steps Of Revascularization

### **Instrumentation**

Most of the authors agree to advocate no instrumentation procedure [3]. Using root canal instrumentation only increase fragility of dentin walls as well as injured stem cells present in the apical area of these dentin walls. This area also contains growth factors imprisoned during dentinogenesis.

Two types of cells are required to achieve a normal root development, odontoblast and epithelial cells of Hertwig's epithelial sheath.

These two cell types are present in abundance in the apical area of immature teeth and are able to resist inflammation. No instrumentation procedure remains consistent with vital stem cells preservation and avoids weakening of already thin root canals.

Cehreli et.al; conducted studies where it was seen that some patients regain sensitivity (vitality) of teeth after revascularization where no endodontic instrumentation was used [3].

### **Irrigation**

Irrigators play a role of primary disinfection. They should have maximum bactericidal and bacteriostatic effect while having minimal cytotoxic effect on stem cells and fibroblast to allow their survival and ability to proliferate [4].

Pulp infection usually spreads apically and creates an acidic environment which is not conducive for tissue regeneration. Bacterial infection of root canal system results in the formation of bacterial bio-films which are found in the canal walls, entrance of dentinal tubules and an apical portion of the canals. The bacteria residing in depth and within the biofilm are in the lay phase and the refractory to the action of antibiotics and irrigators. To ensure optimal root canal disinfection for tissue regeneration, it is necessary to eliminate bio films. Activating the irrigation solution within the root canal system is the only possibility to disintegrate bacterial bio-films in non- instrumented areas. It can be done by endosonics which generates a cavitation process that induces a temperature increase of the irrigator and current propelling the irrigating solution in all crevices. However, precaution should be taken to avoid contact of the endosonic instrument with dentinal walls.

### **Irrigating solutions used in revascularization**

#### *Hydrogen Peroxide*

Solvent properties of hydrogen peroxide are almost non- existent but it has a hemostatic action. Hydrogen peroxide is also an antiseptic by virtue of release of oxygen.

#### *Chlorohexidine*

Chlorohexidine 2% gels was proposed as temporary medication for revascularization. The positively charged molecules are absorbed by the dentinal walls and release over a period of 2 to 12 weeks thus preventing reinfection [5].

#### *Sodium Hypochlorite*

It has a solvent action on necrotic tissue and an antiseptic effect. The cytotoxicity of sodium hypochlorite is proportional to its concentration. Hence a concentration of 2.5% seems to be best compromised between efficiency and toxicity [6].

#### *Iodine*

Iodine has bactericidal, antiviral and sporicidal property. Purulent secretion and blood do not inactivate it [7].

#### *EDTA plus Irrigators*

Chelators are weak acids which react with mineral portion of dentinal walls. They replace calcium ions with sodium ions which combines with a dentin to give soluble salts. EDTA allows better wettability of the irrigator and a removal of the smear layer [8].

### **Disinfection**

The following materials are used for disinfection of root canals.

#### *Calcium Hydroxide*

Calcium hydroxide is a strong base having a pH of 12.8. Its dissociation into calcium and hydroxyl ions gives it antibacterial properties. The hydroxyl ions damage the cytoplasmic membrane, suppresses bacterial enzyme activities, denatures protein damages DNA and thus inhibit any bacterial replication. Calcium hydroxide also has a low coefficient of dissociation (0.17) which allows a long-term release of calcium and hydroxyl ions [9].

However, residues of pulpal necrosis an inflammatory exudate seems to decrease the anti-bacterial power of calcium hydroxide. Acids produce by the bacterias and phosphates from the hydroxyapatite of dentin limits the diffusion of H<sup>+</sup> and OH<sup>-</sup> ions and rapidly neutralizes its pH. According to some researcher's calcium hydroxide increases some expression of some kind of kinases which are indicators for the proliferation of stem cells from the pulp and the periodontal ligament.

Study showed that calcium hydroxide used at a concentration of 0.01mg/ml for canal disinfection allowed survivability of 100% of the apical stem cells.

#### *Triple Antibiotic Paste (TAP)*

According to Chuensombat et al, it appears a single

antibiotic is less cytotoxic than a mixture of antibiotics. No antibiotics have a spectrum large enough to be active against all types of bacteria present in the root canal. So, a combination of antibiotic is essential to cover a maximum range.

Sato et al; developed triple antibiotic paste. The three antibiotics present in the paste are-

1. Minocycline
2. Ciprofloxacin
3. Metronidazole

According to studies, it has been reported that minocycline and ciprofloxacin can induce the formation of fibroblasts. According to Bose et al, the use of triple antibiotic paste shows the highest percentage increase in thickness of the dentinal walls compared to other methods [10]. Triple antibiotic paste has a better action against *Enterococcus faecalis* than calcium hydroxide (Aggarwal, 2012)

*Minocycline* - It is a broad-spectrum tetracycline antibiotic with a broader spectrum than the other members of the group. It is a bacteriostatic antibiotic, classified as a long-acting type.

*Ciprofloxacin* – It has activities against a wide range of gram positive and gram-negative bacteria.

*Metronidazole* - It is an antiprotozoal, antibacterial and anthelmintic nitroimidazole agent with special interest in endodontics for disrupting energy metabolism of anaerobes by hindering the replication, transcription and repair process of their DNA.

One of the main concerns of triple antibiotic paste is development of possible antibacterial resistance.

After the disinfection step, a suitable scaffold which encourages generation of new tissue must fill the root canal. Induction of root canal bleeding is done to bring in situ fibrin, platelets and growth factors. All these elements are necessary for tissue regeneration. These elements provide a matrix from which the growth of new vital tissue is possible in the root canal space. Inclusion of previously prepared protein rich fibrin (PRF) would contribute in bringing more growth factors as well as providing a scaffold for the growth of new tissue.

MTA and Bio dentin are the materials of choice to seal off the root canal to prevent reinfection.

## Conclusion

Based on the results of several literature reviews it has been concluded that the Triple antibiotic paste is the most effective in the pulp revascularization therapy of teeth with incomplete root formation. Along with

irrigation with EDTA and 6% sodium hypochlorite it has been found that there is release of growth factors which aids in disinfection of the root canals and revascularization of the pulp.

## Conflict of interest

The author declares no conflict of interest.

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