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Clinical Practice and Guidelines and Protocols for Revascularization Procedure – A Review

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Abstract:

Several clinical changes are observed in endodontically treated immature permanent teeth with necrotic pulp where apical pathosis may or may not be present. Revascularization is a recent treatment for such cases as an alternative to conventional apexification in management of necrotic immature permanent teeth. Revascularization has been proposed as an improved treatment for irreversibly damaged pulp of immature teeth as it has been shown to preserve the potential for continued root growth in treated teeth. This review will help the clinician to formulate a more effective treatment plan and work accordingly for better results for revascularization procedures.

Key words: Revascularization, Immature permanent teeth, Regenerative Endodontics.

INTRODUCTION:

Management of immature necrotic permanent teeth is being challenging for the clinicians. It creates a situation where achieving the goals of conventional root canal treatment is not only difficult, but even when these are met, it leaves the root short, weak, and prone to fracture.

Other alternative treatment can be, Calcium hydroxide [1] & MTA apexification [2], but both doesn't result it continuous root development, and leading to high risk of root fracture. And another disadvantage is tooth mobility because of poor crown root ratio.

The incidence of cervical root fractures was markedly high in endodontically treated immature teeth when compared to mature teeth (28%-77%) by cvek [3].

Revascularization is a new treatment method for immature necrotic permanent teeth. Indeed, it would provide a vital tooth, helps in continued root development & thickening of dentinal walls [4]. There are numerous case reports and case series on revascularization procedures on not only the single rooted teeth but also multirooted teeth [5].

Iwaya et al [6] in 2001 described a procedure, which they termed revascularization, that was undertaken on a necrotic immature mandibular second premolar with a chronic apical abscess. After 30 months they noted thickening of the root canal walls by mineralized tissue and continued root development.

On the other hand, when apical periodontitis is associated with tooth infection, regenerative endodontic treatment procedure is not considered. But recently, a case report demonstrated continuous root development and apical closure with the application of antibiotics [7].

The drugs required for root canal disinfection can be obtained from any pharmacy and can be easily introduced into the root canal by using readily available instruments. Furthermore, if the revascularization fails, other more traditional treatment options remain available [8].

This article highlights the clinical guidelines and protocols followed for revascularization procedure.

Operative protocol:

First appointment:

An assessment of the patient should be performed, including the state of tooth development, extent and history of the endodontic infection, and the restorability of the crown, before the procedure is undertaken. These factors are important in ensuring that a predictable outcome can be achieved.

Immature permanent teeth with necrotic pulp, with or without apical pathosis, and an incomplete developed root with an apical opening that measures 1 mm or larger are considered suitable candidates for treatment, providing the crown, when damaged, is restorable.

An informed consent must be signed by the patients' parents/ guardians, who must be informed that this is a relatively new procedure with no standardized guidelines.

After obtaining consent, the tooth should be anesthetized, a rubber dam placed, the tooth and working field disinfected, and straight-line access made to allow the necrotic tissue in the pulp chamber to be removed after initial irrigation of the root canal. The canal should be inspected by using dental magnification to confirm or refute the presence of residual vital tissue and the level to which it may be present in the root canal. This is the first phase in determining the type of treatment that will follow (revascularization or apexogenesis).

Instrumentation:

Most of authors agree to advocate no instrumentation procedure. By instrumentation during root canal treatment, there is a increase in fragility of dentinal walls and also injures the stem cells present in apical area of dentinal walls. These also contain growth factor imprisoned during

dentinogenesis. Growth factor and other cells essential for the regeneration process could also be eliminated by instrumentation. Two types of cells are required to achieve a normal root development: odontoblasts and epithelial cells of Hertwig's sheath. These two cell types are present in abundance in the apical area of immature teeth and are able to resist inflammation phenomena [9-11]. These cells will be able to differentiate into secondary odontoblasts that will generate dentin on root canal walls and thus allow root maturation. No instrumentation procedure remains consistent with vital stem cells preservation and avoids weakening of already thin root canal walls [12,13].

According to the study of Cehreli et al. [14], even if the number of cases is not sufficient to be statistically significant, it can be noticed that some patients have regained tooth sensitivity (vitality) after treatment. That was observed only in no instrumentation treatment cases. Thus, elements mentioned so far in favor of no instrumentation protocol seem to be more advised.

Irrigation:

Sodium hypochlorite:

Necrotic tissues are removed by gently irrigating the walls of root canal with 20 mL 2.5% NaOCl dispensed through a syringe with a 20-gauge needle. [7]. NaOCl is a potent antimicrobial agent and effectively dissolves necrotic and organic tissue. Its solvent potential is dependent on its concentration and the frequency of fluid exchange [15,6]. Although higher concentrations are potentially toxic to periapical tissue, Trevino et al [16] found that the survival rate of human stem cells of the apical papilla (SCAP) exposed to 6% NaOCl, followed by 17% EDTA and then 6% NaOCl again, was 74%. Concentrations of NaOCl ranging from 1.25%–6% have also been used and have reportedly yielded favorable results [15,6]. It appears then that the concentration of NaOCl can be adjusted if other precautions inherent to the use of NaOCl are followed.

When irrigating with NaOCl, the needle should be introduced into the root canal to a point 2 mm short of the apical foramen [17,18], and the NaOCl is dispensed slowly from the syringe in order to avoid the entry of NaOCl into periapical tissues. Restricting the needle to a position 2 mm short of the apex is based on the finding that when a syringe plunger is slowly compressed, the solution only extends 1 mm beyond the tip of the needle [19].

Chlorhexidine:

Chlorhexidine 2% gel was proposed as a temporary medication. It is effective against candida and gram+ bacteria by the carryover effect. Indeed, its positively charged molecules confer the property of being adsorbed by the dentin walls and thus allow release of chlorhexidine for at least two to twelve weeks, preventing reinfection of the root canal during this period [20]. Despite this advantage, chlorhexidine does not have an effective dissolving action.

Intracanal medicament:

Calcium hydroxide:

Ca(OH)2 has been advocated as a root canal disinfectant and for stimulation of hard tissue repair (apexification) at the apex of infected immature teeth. Its method of use has now been modified to comply with the demands of treatment designed to stimulate new hard tissue deposition on the root canal walls and continued growth of the root. Its use is advisable when sensitivity to one of the antibiotics used in Hoshino or modified Hoshino paste has been reported [21]. The protocol was highlighted in a 20-tooth case series report by Chen et al. In this case series, the root canals were irrigated with copious amounts of NaOCl and then medicated with an aqueous Ca(OH)2 paste that was placed into the coronal half of the root canal [22]. Bose et al showed that by using a Ca(OH)2 paste in this manner, in time, dentinal wall thickness could be increased by 53.8%. This was significantly greater than the 3.3% increase achieved when the paste was placed apical to that point [5].

Cehreli et al used calcium hydroxide as regenerative endodontic treatment of multirooted immature necrotic teeth in the coronal third of the root canal was a viable alternative to conventional apexification treatment. All teeth in their study demonstrated absence of clinical symptoms, radiographic evidence of periapical healing, progressive thickening of dentinal walls, and continued apical development [14].

Triple antibiotic paste:

Triple antibiotic paste consisting mixture of ciprofloxacin, metronidazole and tetracycline has been used as an intracanal medicament in majority of cases for 3-4 weeks [7].

Since tetracycline causes discolouration, and hence double antibiotic paste containing ciprofloxacin and metronidazole have also been used [8].

Modified triple antibiotic paste containing ciprofloxacin, metronidazole and cefaclor have also been suggested by ruparel et al [23].

Temporary restoration:

Preventing coronal leakage of bacteria into the cleaned and medicated root canal is a primary prerequisite for successful revascularization. It is for this reason that a double coronal restoration is recommended. This is done by placing a sterile cotton pellet over the root canal medicament and then covering the pellet with Cavit cement (3M ESPE, St Paul, MN). The Cavit is, in turn, covered with glass ionomer cement that affords the seal greater resistance to the occlusal forces and wear during the long interval that can occur between appointments [24].

Guidelines for revascularization procedure:

First visit

- Informed consent
- Local anaesthesia & Rubber dam isolation.
- Instumentation – Minimal or no instrumentation.
- Irrigation – Irrigation using 20ml of 1.5% NaOCl and 17% of EDTA solution using Sidevented needle.

- Intracanal medicament –Triple antibiotic paste for 3-4 weeks.
- Temporary seal using Cavit G.

Second visit

- Local anaesthesia without vasoconstrictor & Rubber dam isolation
- Irrigation using 17% EDTA
- Initiation of bleeding by over instrumentation
- Scaffold - PRP or PRF or CGF
- Cervical barrier using MTA or Biodentine
- Double seal using Composite
- Follow up – 3,6,9,12,24 and 48 months.

Failure – Apexification procedure using Calcium hydroxide or MTA

Second appointment

Before proceeding with the next phase of treatment, it is important to ensure that all clinical signs and symptoms have abated. If clinical signs or symptoms persist, the procedures performed in the first appointment should be repeated. If they continue to persist over several appointments, an apexification procedure should be considered [25].

When proceeding with the second appointment, the tooth should be anesthetized before the rubber dam is placed. An anesthetic without vasoconstrictor should be chosen to prevent constriction of the blood vessels in the apical region or a limited flow of blood when bleeding is mechanically induced [26]. After careful removal of the temporary restoration the medicament should be removed by gently irrigatingthe root canal by using a minimum of 20 mL 2.5% NaOCl. The irrigation should be repeated until no medicament is evident in the canal.

From that point on, the irrigation protocol is similar to that used during the first appointment with one exception, the substitution of 10 mL 17% EDTA instead of CHX as a final rinsing solution [27]. Recent studies advocate the use of EDTA at this time and claim that as a chelating agent, it can decalcify the surface of the root canal dentin and expose its collagen fibers [27]. Collagen possesses adhesion motifs for the adhesion of new cells, whereas the decalcification of the dentin releases bound growth factors that can attract new cells and promote their differentiation into cells with odontoblast-like properties [27]. Both are potentially valuable assets in the regenerative procedure. The use of EDTA as a final rinse was promoted by Yamauchi et al [28], who concluded after their animal study that EDTA had no negative effect and helped in the formation of a calcified tissue that led to strengthening of the root walls. This protocol was also proposed by Trevino et al [16], who showed that irrigation with 17% EDTA or a combination of 17% EDTA and 6% NaOCl was compatible with stem cell survival, whereas irrigation protocols that included 2% CHX were not. It was feared that because of its substantivity, CHX could interfere with the binding of SCAP cells to the extracellular dentinal matrix [16].

Scaffold:

In few cases, successful revascularization has occurred without initiating the blood clot inside the root canal [29]. Platelet-rich plasma (PRP) and platelet-rich fibrin (PRF) obtained from the patient have also been used a scaffold instead of blood clot. Torabinejab M used PRP as scaffold for revascularization of a maxillary second premolar teeth [30]. Platelet-rich plasma obtained from the patient was injected into the canal space. The process for preparing PRP is simple and it is easy to use, additionally it contains growth factors, anti-inflammatory properties and promotes healing. Platelet-rich plasma clot also provides a good matrix for correct placement of MTA [29].

But, the disadvantage of PRP/PRF will be the additional cost and the fear in patients of withdrawing blood. When compared to PRP, the PRF releases growth factors and cytokines slowly in a controlled manner. It has been found that PRF stimulates cell proliferation and differentiation of human dental pulp cells [31].

CGF

The fibrin buffy coat is a major component in CGFs. In the present study, the fibrin block is cut into pieces of approximately 1–2 mm, mixed with BPBM and put into the bone defects. Unimpeded absorption, adhesion and maturation of the fibrin clot for formation of a connective tissue attachment over a long junctional epithelium plays a vital role in periodontal regeneration [32]. The CGFs not only improve the wound stability, which is essential for the establishment of a new connective tissue attachment to a root surface, but also provide a scaffold supporting cytokine attachment and cellular migration [33].

Cervical Barrier:

Mineral trioxide aggregate has been used in majority of the case reports as a cervical barrier material because of its favorable physical and biological properties [34]. A minimum of 4 mm of MTA is necessary to ensure a good seal. Once the MTA is set the access cavity is further restored using composite or glass ionomer cement ensuring a double seal [35]. Correct placement of MTA below the CEJ might be difficult and it has been mentioned in a few cases that it gets pushed at a deeper level. Petrino J et al suggested the placement of collagen matrix over the blood clot which will inturn enable proper placement of MTA [36].

Nosrat A et al used calcium enriched mixture (CEM) as a barrier material instead of MTA in two of their cases. According to them, CEM is a tooth-colored water-based cement which has physical and biological properties similar to MTA and its surface characteristics is similar to human dentin and, hence, it might promote differentiation of stem cells [35].

CONCLUSION:

In the clinical management of infected immature tooth, case selection should be done carefully and full disclosure of patient regarding goals and limitation of the treatment are essential to make this form of mainstream treatment an alternative one.

Future studies with randomized controlled clinical trials are required to give us definite results on decision making when comes to management of necrotic immature permanent teeth using regenerative protocol

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