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Original Research

Revascularization: A Biological Approach for Non Vital Immature Teeth

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ABSTRACT:
The importance of careful case assessment and accurate pulpal diagnosis in the treatment of immature teeth with pulpal injury cannot be overemphasized. The treatment options starts from indirect pulp capping, direct pulp capping, partial pulpotomy, full pulpotomy, apex genesis, apexification and ending up with revitalization. Revascularization of necrotic immature permanent teeth is an alternative biological treatment modality to conventional apexification using calcium hydroxide or MTA. Revascularization, as defined by Andreason, is the restoration of the vascularity to a tissue or organ. Revascularization in necrotic immature permanent teeth results in maturogenesis, which allows continued thickening of root dentin and apical closure. Hence present review of literature provides complete overview on concept of revascularization.
Keywords: Revascularization, Open apex, Non-vital teeth

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INTRODUCTION

In young children, anterior teeth by virtue of their position in the dental arch are prone to trauma. In cases of complicated tooth fracture with the loss of pulp vitality, cessation of root development with an open apex is a serious sequel. Management of such immature, non-vital teeth is a challenge. The treatment modalities for management of immature permanent teeth include apexogenesis with calcium hydroxide, apexification either with calcium hydroxide or mineral trioxide aggregate (MTA), custom-made roll cone technique, and periapical surgery. Recent advances have led to a paradigm shift from conventional replacement procedures to regenerative protocols.[1]

Recently, revascularization is introduced as a new treatment modality for immature non-vital teeth. Revascularization can be defined as the invagination of undifferentiated periodontal cells from the apical region in immature teeth. Tissue in growth is directed toward the root canal space after passive decontamination that removes, partially or totally, pulp tissue and/ or its necrotic remnants. Root canal space filled with blood clots from periapical tissues, which can contribute to transporting stem cells inside the root canal space. Periodontal/periapical cells have been related to the desired outcomes of pulp revascularization (root-end development and apical closure).[2,3]

The stem cells from apical papilla (SCAP) are capable of differentiating into odontoblast-like cell-forming

root dentin. Another type of mesenchymal cells, which are called dental pulp stem cells (DPSCs), were discovered, to have the ability to differentiate into odontoblast-like cells and form pulp/dentine-like complex. Thus, the concept of revascularization has been used to form the vital tissue inside the root canal.[2] Hence present review of literature provides complete overview on concept of revascularization.

EMERGENCE OF REVASCULARIZATION

Revascularization concept was first introduced by Ostby et al.[4] in 1961 and Rule and Winter[5] in 1966 documented root development and apical barrier formation in cases of pulpal necrosis in children. Ham et al.[6] in 1972 cited the apical closure of immature pulpless teeth in monkeys. Iwaya et al.[7] in 2001 and Banchs and Tropein[8] 2004 demonstrated the advantages of this treatment modality that resulted in a radiographically apparent normal maturation of the entire root. Pulp revascularization is described as a regenerative treatment of necrotic immature teeth that involves inducing the formation of a blood clot within the previously disinfected canal, by involving the recruitment of stem cells from the apical region.[9] Regeneration of tissue comparable to pulpal tissue and to reactivate dentinogenesis is the key objective of this therapeutic approach which will become non-existent following the necrosis of pulp tissue, and subsequently allowing the development of the root.[10]

PROTOCOL OF REVASCULARIZATION

CASE SELECTION

The first issue is case selection; the best available evidence indicates that this treatment should be considered for incompletely developed permanent tooth that has an open apex and is negative to pulpal responsiveness testing. Teeth with an apical diameter more than 1 mm demonstrate a greater likelihood of revascularization.[8]

The presence of a periradicular radiolucency or a negative vitality test are not determining factors in case selection as vital pulp tissue or apical papilla may be present in the canal and at the apex.[11]

FIRST APPOINTMENT

The treatment alternatives, risks, and potential benefits should be described to the patient and guardian after collecting clinical information and establishing pulpal and peri-radicular diagnosis. Following informed consent, the tooth is anaesthetized, isolated and accessed. Minimal instrumentation is done. The root canal system is copiously and slowly irrigated with 20 ml of NaOCl followed by 20 ml of 0.12 – 2% chlorhexidine. Since canal disinfection relies considerably on chemical irrigants, it is important to place the needle into the apical third and irrigate using needles with a closed end and side port vents together with a slow rate of infusion to help to reduce any irrigants passing through the open apex.[12] Based on disinfection method pulp revascularization techniques can be of two types: One using calcium hydroxide and second is by using a triple antibiotic paste. Both are two visit procedures. If triple antibiotic paste is used, ensure that it remains below CEJ (minimize crown staining). Seal access cavity with 4 mm Cavit and dismiss patient for 3-4 weeks.

SECOND APPOINTMENT

Patient is evaluated for resolution of any signs and symptoms of an acute infection (swelling, pain, sinus tracts etc).The antimicrobial treatment is repeated if resolution has not occurred.[12,13]

Anesthesia without vasoconstrictor is used which will facilitate the ability to induce bleeding into the canal, following isolation and reestablishment of coronal access, tooth should be copiously and slowly irrigated with NaOCl and saline, with gentle agitation with a small file to remove antimicrobial paste. Dry the canal with sterile paper points. Haemorrhage is induced by over instrumentation with either endodontic files or an endodontic explorer penetrating slightly into the remaining pulp tissue or periradicular tissue. This procedure induces bleeding into the canal, and the bleeding is left for 15 min so that the blood would clot in the canal and stopped at a level 3 mm below CEJ. MTA is then placed over the blood clot.[2,11]

FOLLOW-UP

- Clinical and radiographic exam:
- No pain or soft tissue swelling (often observed between first and second appointments)
- Resolution of apical radiolucency (often observed 6-12 months after treatment)
- Increased width of root walls (this is generally observed before apparent increase in root length and often occurs 12-24 months after treatment)
- Increased root length
- Apical closure

DISCUSSION

Regenerative Endodontics is a widely used treatment option nowadays. Dentinal wall thickening and root lengthening are extensively seen with it as compared to apexification.[10] Therefore; offer an alternative approach to the management of traumatized immature permanent teeth with pulp necrosis and periradicular infection.[15]

There are a number of theories that explain the mechanism of revascularization. The periradicular zone of immature young permanent teeth has many multipotent periodontal cells which have great potential to differentiating into new fibroblast and cementoblasts.[16] Hence, it has been suggested that differentiated cementoblasts and fibroblast are responsible for increasing dentinal walls and apical closure.[17] A second possibility involves the in growth of SCAP (Stem cell from apical papilla) that could proliferate inside root canals through the blood

induction of periapical tissues, since these cells have high proliferative capacity, probably being transported inside root canals in association with bleeding induced from the periapical tissue.[16] The third possible mechanism could be attributed to the presence of stem cells in the periodontal ligament which can proliferate, grow into the apical end and within the root canal, and deposit hard tissue both at the apical end and on the lateral root walls.

Banchs and Trope documented a case report where revascularization of immature permanent teeth with apical periodontitis was made possible by inducing the blood clot into the pulp canal by mechanically irritating the periapical tissues which they attributed to the total disinfection of canal. Apart from the root canal disinfection and use of a suitable scaffold, the quality of the coronal restoration is also very important to achieve success of revascularization treatment. This critical requirement of a bacterial-tight coronal seal can be met with the use of composite, MTA, cavit, glass ionomer, or their combinations. In this present case coronal seal is obtained by MTA.

Infection control seems to be crucial for the success of pulp revascularization. In the majority of the experiments described in this review, the three antibiotic paste (TAP) consisting of metronidazole, ciprofloxacin and mynociclin was the medication most used. Metronidazole is an antiprotozoal, antibacterial and antihelminthic nitroimidazole agent with special interest for endodontics for disrupting energy metabolism of anaerobes by hindering the replication, transcription and repair process of their DNA. Anaerobic presence in the root canals implies in more resistant infections, and therefore the association with ciprofloxacin, which has activity against a wide range of gram-negative and gram-positive bacteria added more efficacies to the paste. Up to this moment, there is no known cross-resistance between ciprofloxacin related in the endodontic microflora. Minocycline 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.[18]

Various reported cases in the literature tends to demonstrate the clinical interest of these biological approach, but the variability of the results obtained encourages us to focus on the nature of the biological tissue formed in the root canal, and to raise the issue of whether the implementation of root canal vascularisation alone can be considered as a regeneration or a simple repair.[19-21]

Some clinical cases report the return of tooth sensitivity, with positive responses to the vitality test, probably confirming the regeneration of nerve tissue in the root tissue filling the canal, as well as a resumption of root edification and the thickening of its walls. All these elements therefore tend to suggest that real pulp tissue has been regenerated within the tooth. However, histological differentiation of the tissues formed still impossible with only clinical and radiological examinations.[22]

MERITS OF REVASCULARIZATION[11]

1. Obturation of the canal is not required unlike in calcium hydroxide-induced apexification, thus eliminates the chance for root fracture during lateral condensation.
2. Achieving continued root development (root lengthening) and strengthening of the root as a result of reinforcement of lateral dentinal walls with deposition of new dentin/hard tissue.
3. Root canal revascularization via blood clotting is a relatively simple and practical approach which can be accomplished with presently available instruments and materials. Moreover, the possibility of immune rejection and contamination can be averted since the root canal system is filled with patient's own blood cells.

DEMERITS OF REVASCULARIZATION[3, 11]

- The reliance on patient's compliance to carry out the procedure in multiple visits and the lack of long term follow-up studies makes revascularization procedure a supplement but not a substitute to the already existing treatment protocols like apexogenesis, apexification, or partial pulpotomy.
- Also, the concentration and composition of the progenitor/stem cells entrapped in the fibrin clot is unpredictable, particularly in older patients and may lead to disparity in the results.
- Difficult to achieve it in fully formed permanent teeth.
- Potential clinical and biological complications such as crown discoloration, development of resistant bacterial strains (due to long-term use of antimicrobial agents), and allergic reaction to intracanal medicament.

CONCLUSION

Revascularization is an effective method for inducing maturogenesis in nonvital, immature teeth. Complete root development is possible with regenerative endodontic procedures, and there is a paradigm shift in the endodontic management of immature permanent teeth with necrotic pulps using regenerative endodontic procedures. In future conventional apexification procedures might be replaced completely by these newer methods.

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