



APEXIFICATION - A NARRATIVE REVIEW

Dental Science

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ABSTRACT

Pulp necrosis of immature permanent teeth represents a significant challenge for clinical management as root development ceases and open apices remain. The aetiology of pulp necrosis in immature permanent teeth can include caries, trauma or the presence of the dental anomalies. Depending upon the vitality of the affected pulp, two approaches are possible, apexogenesis or apexification. Present review of literature includes the various aspects of management of immature non vital tooth with recent advancement in procedures and materials in achieving the apical closure of affected root apices.

KEYWORDS

APEXIFICATION, APEXOGENESIS, SINGLE VISIT APEXIFICATION

INTRODUCTION

The presence of healthy pulp is essential for root development and apical closure. It is well established that pulp necrosis of immature, permanent teeth can halt continued root development, producing a tooth with an open apex. The most common causes of pulp necrosis in immature, permanent teeth are dental caries. Dental caries is a chronic infectious disease resulting from the penetration of oral bacteria into the enamel and dentin. Microorganisms subsequently trigger inflammatory responses in the dental pulp. The proliferation and metabolic activity of these microorganisms lead to the release of bacterial components into dentinal tubules and their diffusion towards the peripheral pulp. Bacterial invasion results in irreversible chronic pulp inflammation, most often after a long phase of chronic inflammation. Subsequently, pulp necrosis, infection of the root canal system, and periapical disease may occur. Other causes include dental trauma, dental anomalies like dens evaginatus and dens invaginatus etc.^[1,2]

Apexification of non-vital immature teeth with calcium hydroxide has proven to be a reliable and the most welcome addition to the therapeutic armamentarium since Frank described it in 1966. The unpredictable and lengthy course of treatment presented challenges, particularly as it required a high level of patient compliance. For this reason, one visit apexification has been suggested.^[3]

In 1993, a new endodontic material, mineral trioxide aggregate (MTA) was developed by Torabinejad, and coworkers. It has been proposed as a material for one visit apexification as it combines a bacteriostatic action, biocompatibility and a favorable sealing ability.^[3]

Apexogenesis V/S Apexification^[4]

- **Apexogenesis (Root formation):** Apexogenesis describes the continued physiologic development and formation of the root's apex in vital young permanent teeth. It can be achieved by implementing the appropriate vital pulp therapy techniques.^[3]
- **Apexification (Root end closure):** Apexification is a technique of inducing root end closure in an immature non-vital permanent tooth by removing the coronal and radicular tissue and placing a suitable biocompatible agent.

Causes of open apices^[3]

- Incomplete development
- Extensive apical resorption
- Root end resection
- Over-instrumentation

Types of open apices

- Non blunderbuss: Broadly opened apex (Cylinder – shaped root canals).
- Blunderbuss: Funnel shaped apex (Apical opening can be wider than the coronal root canal orifice (inverted root canal).

DIAGNOSIS

Clinical assessment of pulpal status requires a thorough history of subjective symptoms, careful clinical and radiographic examination and performance of diagnostic tests.^[4]

An accurate pain history must be obtained. The duration and character of the pain and aggravating and relieving factors should be considered. Duration of pain may vary but pain that lasts for more than a brief period (a few seconds) in a tooth with a vital pulp has been thought to be indicative of irreversible pulpitis. When pain is spontaneous and severe, as well as long lasting, this diagnosis is almost certain. If the pain is throbbing in character and the tooth is tender to touch, pulpal necrosis with apical periodontitis or acute abscess is likely. Confirmation from objective tests is necessary which include visual examination, percussion testing and thermal and electric pulp testing. The presence of a swelling or sinus tract indicates pulpal necrosis and acute or chronic abscess respectively. Tenderness to percussion signifies inflammation in the periapical tissues.^[5]

Vitality testing in the immature tooth is inherently unreliable as these teeth provide unpredictable responses to pulp testing. Prior to completion of root formation, the sensory plexus of nerves in the sub-odontoblastic region is not well developed and is not recommended.^[6]

METHODS FOR THE TREATMENT

According to Morse et al (1990)^[7] there are at least 5 methods of treating a tooth that has a necrotic pulp and an open apex.

1. A customized cone (Blunt end, rolled cone): Filling the root canal with the large (blunt) end of a gutta percha cone or customized gutta percha cones with a sealer.
2. A short fill technique: Filling the root canal well short of the apex (before the walls have diverged) with gutta percha and sealer or zinc oxide eugenol (ZOE) alone.
3. Periapical surgery: Filling the root canal with gutta percha and sealer and then performing periapical surgery with or without a reverse seal.
4. Apexification (Apical closure induction): Inducing apical closure by the formation of an apical stop [Calcium hydroxide, Ca (OH)₂ is generally used] against which a permanent root canal filling can subsequently be inserted.
5. One visit apexification: Placing a biologically acceptable substance in the apical portion of the root canal (Dentinal chips or tricalcium phosphate have been used) thus forming an apical barrier. This is followed by filling the root canal with gutta percha and sealer.

Calcium Hydroxide

Although a variety of materials have been proposed for induction of apical barrier formation, calcium hydroxide has gained the widest acceptance. Calcium hydroxide was introduced by Hermann in the 1920's for endodontic treatment. The use of calcium hydroxide was first introduced by Kaiser in 1964 who proposed that this material mixed with camphorated Para chlorophenol (CMCP) would induce the formation of a calcified barrier across the apex. This procedure was popularized by Frank (1966) who emphasized the importance of reducing contamination within the root canal by instrumentation, medication and decreasing the canal space temporarily with a

resorbable paste seal.^[8]

Klein SH et al. (1974) and others described successful induction of an apical barrier using calcium hydroxide and Cresatin (Premier Dental Products). Cresatin had been shown to have minimal inflammatory potential as a root canal medicament and to be significantly less toxic than CMCP. To further reduce the potential for cytotoxicity, the use of calcium hydroxide mixed with saline, sterile water or distilled water has been investigated with similar clinical success. Heithersay GS (1970) and others have used calcium hydroxide in combination with methylcellulose (Pulp dent Corporation, Watertown, MA, USA). Pulp dent has the advantage of decreased solubility in tissue fluids and a firm physical consistency.^[8]

Mechanism of action of Ca(OH)₂ to induce formation of a solid apical barrier:^[4]

- Presence of high calcium concentration increases the activity of calcium dependent pyrophosphatase.
- Direct effect on the apical and periapical soft tissue
- High pH, which may activate alkaline phosphatase activity
- Antibacterial activity

Disadvantages of conventional Ca(OH)₂ apexification^[9]

- Patient Compliance
- Fracture before completion of treatment
- Inconvenience of multiple appointments in the young adult patient
- Precise prognostic assessment sometimes impossible
- Financial

Single-Visit Apexification

One-visit apexification is defined as the non-surgical condensation of a biocompatible material into the apical end of the root canal. The basis is to create an apical barrier that would facilitate the root canal to be filled instantly. Only an artificial apical stop is created and no effort to induce root end closure is taken. MTA acts as a scaffold for the formation of hard tissue and provides better biological seal. In this technique thorough cleaning and shaping of the root canal system is done. Then, MTA is introduced as an apical seal followed by the immediate placement of a suitable bonded restoration within the root canal. Though the advances with MTA and bonded restorations show a better outcome, it cannot yield the result that apexogenesis can attain, i.e. maturation of the root end with better thickness of the root. Therefore, alternative approaches that allow the apical maturation should be pursued.^[10]

Paradigm shift in management of non-vital teeth with open apex

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).^[11]

CONCLUSION

Calcium hydroxide apexification remains the most widely used technique for treatment of necrotic teeth with immature apices as it has high success rates are. As compared to calcium hydroxide, MTA is effective in treating immature permanent teeth with necrotic pulps with the advantage of reduced treatment time and more predictable barrier formation. The shortcoming is similar to calcium hydroxide that the placement of an apical plug does not account for continued root development along the entire root length. 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. Prospective clinical trials comparing these alternative techniques are required.

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