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Review Article

Current key to clinical success in pulp capping: A review

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ABSTRACT

The aim of pulp capping is the preservation of tooth vitality by forming a barrier between the pulp and the surrounding environment. A successful formation of this barrier avoids the need for further treatment and helps in the conservation of the pulp-dentin complex. A mineralized tissue barrier can only be formed when there is a significant reduction in pulp inflammation and infection. The initiation of the healing process in pulpal inflammation presents a beneficial chance to ensure the long-term effectiveness of pulp capping treatment. Various materials employed for pulp capping induce the formation of a mineralized tissue barrier, which is a favorable response. Therefore, this review focuses on when and where to perform the procedure for the preservation of pulpal vitality and the assessment of the outcome of pulp capping to understand the successfulness of the treatment. It also focuses on methods that lead us towards a fortunate treatment.

1. Introduction

The dental pulp is a highly specialized mesenchymal tissue characterized by odontoblasts and surrounded by rigid mineralized tissue.[1] Primary function of the pulp is dentin formation; its other functions are providing nutrition to the dentin and the innervation and defense of the tooth.[2] An injured dental pulp has a limited potential for self-recovery. Here comes the pulp-dentin complex wherein the dental pulp and dentin function as a pivotal unit in the immune defense against noxious stimuli and tissue repair and regeneration during trauma and infection. Minimal invasive dentistry promotes the preservation of vital tooth structure in an effort to avoid damage to the pulp-dentin complex.[3] Management of exposed pulp, can be accomplished by pulp capping procedure. Pulp capping prevents the pulp from external stimuli by forming a seal between the oral environment and the pulp, which in turn prevents the progression of microorganisms. Therefore, this review focuses on preservation of pulpal vitality, pulp capping procedures and outcome of pulp capping to understand the successfulness of the vital pulp therapy.

2. Vital Pulp Therapy

Vital pulp therapy is recommended for all teeth diagnosed with reversible pulpitis or pulp which is partially inflamed in which remaining healthy tissue can be conserved to generate a hard tissue barrier that seals and protects the pulp from insults of microbial invasion.[4] The guidelines of the American Academy of Pediatric Dentistry (AAPD) state that —Teeth exhibiting provoked pain of short duration relieved with over-the-counter analgesics, by brushing, or upon the removal of stimulus without signs and symptoms of irreversible pulpitis, have a clinical diagnosis of reversible pulpitis are candidates for vital pulp therapy. The primary objective of the vital pulp therapy is to encourage formation of a protective hard tissue barrier after

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an injury. The process of forming a hard tissue barrier begins with the recruitment of odontoblast-like cells from the cell-rich zone and sub-odontoblastic layer, which leads to their regeneration.[5]

The treatment modalities for vital pulp therapy are direct pulp capping, indirect pulp capping, partial pulpotomy, and full pulpotomy.

3. Indirect Pulp Capping

Indirect pulp capping is a dental procedure carried out on a tooth that has a deep carious lesion close to the pulp, but does not exhibit any signs or symptoms of pulp degeneration. The objective of this procedure is to eliminate the cariogenic microbiota that alters the acidic profile and pH of the lesions, and to prevent the proteolytic degradation of organic material. This contributes to the formation of tertiary dentin and sclerosis of dentinal tubules, thus limiting the progress of the carious process.[6] This treatment modality can be performed by 2 methods which are:

3.1. Stepwise excavation of the pulp

In stepwise treatment, the demineralized carious tissue is partially removed, a layer of carious dentin is left over the pulp and the tooth is temporarily sealed. The undermined enamel is removed with carbide bur #245 at high-speed with copious air/water spray. Caries is completely removed from the cavosurface margins and all lateral walls of the cavity preparation with carbide burs #2 to #8 at low speed.[7] One common technique is to remove only the "infected dentin". Infected dentin is the one that is demineralized with denatured collagen, infiltrated with bacteria, and irreparably damaged. The "affected dentin" is left in place. Affected dentin is one that is demineralized but with the collagen structure still largely intact, is bacteria-free, and still has the potential for remineralization.[8] The affected dentin is then covered with a base and/or liner with the hope that it will remineralize over time, forming hard bacteria-free dentin. After 8 to 12 weeks, the second step is performed.[7] The tooth is then reopened, residual caries removed, and then permanently sealed.[9]

3.2. Single visit excavation

In this, the carious lesion as much as possible is removed without inducing pulpal exposure. In the deepest aspect of the preparation, a medicament is placed, and a definitive restoration is placed over it. A single-visit excavation does not require a second visit to restore the tooth, unlike the step-wise excavation, and there is no risk of an inadvertent pulpal exposure when re-entry of the tooth occurs.[10] The single-visit procedure of caries removal involves the risk of exposing and even breaching the pulp, leading to less predictability of the treatment. Nonetheless, the removal of any type of caries halts ongoing cariogenic activity and creates a sound and well-mineralized dentin surface that can serve as a stable foundation for subsequent dental restoration.[11]

The outcome of indirect pulp capping can be assessed by the clinical symptoms as well as radiographic signs of the patient. According to the guidelines on pulp therapy for primary and immature permanent teeth (The American Academy of Pediatric Dentistry 2014), the procedure is successful if, clinically**:**

1. The vitality of pulp is maintained.
2. There is an absence of posttreatment signs or symptoms such as sensitivity, pain, or swelling.

Radiographically we can assess by:

1. Occurrence of pulpal healing and reparative dentin formation.
2. Absence of radiographic evidence of internal or external root resorption, periapical radiolucency, abnormal calcification, or pathologic changes.
3. Teeth with immature roots shows continued root development and apexogenesis.[12]

The quality of tertiary or reparative dentin formed is quite variable. If the irritation to the pulp is relatively mild, then the tertiary dentin formed may resemble primary dentin in terms of tubularity and degree of mineralization. The dentin which is deposited in response to a deep carious lesion may be relatively atubular and poorly mineralized, with many areas of interglobular dentin.[5]

3.2.1. Direct pulp capping

Direct pulp capping is defined as placing a dental material directly on a mechanical or traumatic vital pulp exposure and sealing the pulpal wound to facilitate reparative dentin formation and maintenance of the vital pulp. The aim of direct pulp capping is to maintain the healthy pulp by sealing it against bacterial invasion. Its objective is to protect the pulp from bacterial invasion and to induce dentin bridge formation at the exposure site.[13] According to the American Association of Endodontists (AAE), direct pulp capping is indicated when there is an occurrence of exposure of clinically vital and asymptomatic pulp mechanically or during dental dam isolation of the tooth, bleeding at the exposure site is controlled after exposure, an adequate seal can be maintained coronally. Direct pulp capping is contraindicated when there is spontaneous and nocturnal toothaches, excessive tooth mobility, thickening of the periodontal ligament, radiographic evidence of furcal or peri-radicular degeneration, uncontrollable hemorrhage at the time of exposure, purulent or serous exudate from the exposure.[14]

The first step in direct pulp capping is the isolation of the tooth after effective anesthesia followed by caries

removal. Caries can be identified by usage of sharp explorer tip to provide positive tactile feedback. The extent of the caries can be determined radiographically and visually as well. The tactile sense was used to differentiate soft from hard dentin to determine infection from non-infected dental tissues. This procedure has shortcomings as the ability to remove caries varies amongst operators and during different time periods for the same operator. To overcome this, caries removal was enhanced with the aid of a caries detector dye and optical magnification. Following the detection and extent, caries removal is done. To gain access to the carious lesion, a high-speed drill on the handpiece is used followed by a low-speed handpiece to remove the carious dentin.[15] During the removal of caries if the pulp is exposed then direct pulp capping is performed. After this, hemorrhage control should be achieved. The most common method to control bleeding is to apply pressure to the exposure site with a sterile cotton pellet until hemorrhage subsides.[16]

There are various substances to control pulp bleeding such as saline solution, sodium hypochlorite, MTAD, 30% hydrogen peroxide, 2% chlorhexidine, ferric sulfate, and epinephrine. Electrosurgery is another method of controlling hemorrhage. Lasers such as CO2 laser, Nd: YAG laser, Er: YAG laser, etc. can also be used for controlling the bleeding. If the hemorrhage control cannot be achieved after 10 minutes of hemostatic agent, the pulp is likely to be irreversibly involved and a full pulpotomy or pulpectomy is recommended then.[5]

The microorganisms remaining after meticulous caries removal and sodium hypochlorite disinfection can compromise the treatment. Therefore, with the application of MTA or calcium silicate cement, a cement thickness of 1.5mm or greater increases the likelihood of bacterial neutralization and reduces further microbial challenges. After decontamination and application of a hemostatic agent, the second step is performed in which a biocompatible material is placed to seal the pulp and prepare it for initiation of reparative dentin formation. Decontamination can be done by use of antiseptics like 2% chlorhexidine and 0.1% octenidine dihydrochloride.[16] Borompiyasawat P et al found that applying 2% CHX on demineralized dentin enhances the remineralization of the dentin beneath the restoration.[17]

3.2.2. One-step pulp capping

Includes the following protocol,

1. With dental dam isolation, a cavity preparation outline is made using high-speed burs under constant water cooling.
2. If caries is present, excavate using a round bur at low speed or use hand instruments.
3. Rinse the cavity and the exposure site with 2.6% to 5% sodium hypochlorite. Heavy bleeding can be controlled with a cotton pellet moistened with sodium hypochlorite.
4. Prepare the pulp capping material according to the mixing instructions.
5. Using a small ball applicator or similar device, apply a small amount of the capping material over the exposure.
6. Remove excess moisture at the site with a dry cotton pellet.
7. Apply a small amount of flowable compomer or an equivalent lightcure resin-glass ionomer liner to cover the capped material.
8. Etch the remaining cavity walls with 34% to 37% phosphoric acid gel for 15 seconds. Rinse thoroughly.
9. The cavity is dried gently, leaving the dentin moist but not wet. Apply a bonding material and cure according to the instructions.
10. Place a composite resin to complete the restoration Cure according to its instructions.
11. Assess the pulp vitality in the next appointment. Pulp vitality and status should be assessed radiographically every 3 to 6 months or as needed.[18]

3.2.3. Two-visit pulp capping

1. After profound local anesthesia has been obtained, the tooth is isolated with a dental dam and additionally sealed with an agent if leakage is present. A high-speed diamond or carbide bur is used to remove undermined enamel and soft debris is removed with a spoon excavator.
2. After carious dentin has been exposed and air-dried, a caries detector dye is applied for 10 seconds and the tooth is washed and dried with a two-way syringe. Caries removal is completed with a spoon excavator and/or slow speed #6-2 carbide round burs until minimal or no deeply stained dentin is evident. The dentin is washed and dried again and the caries detector is reapplied on the dentin for 10 seconds. The process is repeated meticulously until no or only light pink staining is evident (usually 5 to 7 applications).
3. Bleeding can be controlled by placement of a cotton pellet moistened with a 3% to 6% sodium hypochlorite for 20 to 60 seconds if pulp exposure occurs during caries removal process.
4. A 3% to 6% sodium hypochlorite solution with or without a cotton pellet is place directly against the exposure for a contact time of 1 to 10 minutes. The diagnosis is changed to irreversible pulpitis when hemostasis cannot be achieved within 10 minutes.
5. After hemostasis is achieved, the dentin should be gently washed with water and dried to remove excess sodium hypochlorite before the pulp capping material is applied. The material is mixed according to manufactures instructions. The cement should have

a minimum thickness of 1.5mm.

6. After placement of pulp capping material and coverage with a flat cotton pellet or gauze, a durable and removable provisional material is used. Unbonded Photocore is recommended as a reliable option because of its ease of handling and unique polymerization characteristics.
7. The return appointment should be scheduled 1 to 10 days after placement of the material. After profound anesthesia is obtained, the tooth is isolated with dental dam. The provisional material is removed with high-speed diamond or carbide bur using water coolant. The cotton pellet or gauze is removed. A bonded composite restoration is placed following the manufacturer's instructions after the capped material has been checked to ensure proper curing.
8. After completion of permanent restoration, the occlusion is checked and adjusted as required.

An initial assessment of the treated case at 6 to 12 weeks, followed by a review at 6 and 12 months after treatment is recommended.[5]

4. Assessment of Outcome

The criteria for assessment of the outcome of pulp therapy in the Consensus report of the European Society of Endodontology (2006) includes,

4.1. Clinically

1. Absence of pain.
2. Absence of sinus tract or soft tissue swelling.
3. Normal response to pulp sensitivity tests.
4. Absence of clinical signs of root resorption and apical periodontitis.
5. Absence of tenderness to palpation of adjacent soft tissues.
6. Absence of tenderness to percussion and pressure of tooth.[4]

4.2. Radiographically

1. Radiologic evidence of dentinal bridge formation.
2. Radiologic evidence of continued root formation in immature teeth.
3. Absence of radiographic signs of root resorption and apical periodontitis.[19]

5. Conclusion

Recent advances in pulp biology and dental materials have provided strategies for the treatment of healthy and partially inflamed pulp. The vital pulp can be successfully treated if the clinician has an improved understanding of diagnosis and case selection. Hemostasis, caries removal, magnification, capping materials, and restorative materials are other factors for the successfulness of the treatment.

6. Conflict of Interest

None.

7. Source of Funding

None.

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