



Review Article

MANAGEMENT OF DEEP CARIOUS LESIONS: A REVIEW

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Abstract

Caries prevalence is at peak in world at present specially affecting older and socially disadvantaged groups in Western cultures. If caries spread is not stopped at early stages it will advance through dentine stimulating pulpitis and eventually pulp infection and necrosis; however, if conservatively managed, pulpal recovery occurs even in deep carious lesions. For selective (partial) caries removal and a reduced pulp exposure risk, minimally invasive treatment strategies with one step or two step, has been advocated. Management strategies for the treatment of the cariously exposed pulp are also shifting with avoidance of pulpectomy and the re-emergence of vital pulp treatment (VPT) techniques such as partial and complete pulpotomy. Present review article concentrates on the procedures for the management of deep carious lesion.

Keywords: Apexification, Apexogenesis, Caries, Pulpotomy.

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INTRODUCTION

For management of deep caries, pulp vitality maintenance and biologically based management strategies are at the core.¹ By selective caries removal and single or two visits restoration, pulp exposure can be avoided in radiographically deep caries and asymptomatic or mildly symptomatic teeth. One of the basic steps in operative procedure is the removal of carious dentin. Severity of the disease and the age of the pulp determines the caries progression.²

DISCUSSION

According to Sturdevant, Dental caries is an infectious microbiologic disease of the teeth that results in localized dissolution & destruction of calcified tissues.³ Deep caries lesions points toward the potential exposure of the pulp. When on an X-Ray, the penetration depth is in the range of three fourths of the entire thickness of the dentin or more, deep caries lesion is said to be present.⁴

Remaining Dentin Thickness

According to Stanley, for pulp protection, the remaining dentin under the cavity preparation should be at least 2 mm thick. Application of liners and bases depend on the amount of remaining dentin thickness (RDT). In a shallow tooth excavation, there is no need for pulpal protection other than in terms of chemical protection in which RDT is 1.5 to 2 mm. The basic factor in determining the choice of using cavity varnish, liner or cavity base is the thickness of remaining dentin bridge at the deepest portion of the cavity preparation.⁵

Chemo-mechanical caries removal⁶

For minimally invasive caries removal, Carisolv is used. The strategy of the chemomechanical caries removal system is the chemical disruption of denaturated collagen and removal of the unsupported mineral by gentle scraping. To remove the softened material, a set of specially designed instruments has been used. Carisolv gel consists of two carboxymethylcellulose based gels: a red gel containing: amino acids (glutamic acid, leucine and lysine), NaCl and NaOH Erythrosine (added in order to make the gel visible during use) and a second gel containing sodium hypochlorite

Advantages of Carisolv

The patients perceive the method as much more comfortable than drilling and anaesthetics are seldom needed and avoids removal of unnecessary healthy dental tissues.

Caries Detection Dye⁷

The irreparable areas of dentin will distinctly stain. Apply a sol of 0.5% basic fuchsin in propylene glycol to dentin for 10sec, then thoroughly wash the preparation with water. 1% acid red solution in propylene glycol.

Indirect Pulp Capping^{4,8}

It is defined as a procedure wherein the deepest layer of the remaining affected carious dentin is covered with a layer of biocompatible material in order to prevent pulpal exposure and further trauma to the pulp.

Indications

Deep carious lesions, Minimal pulpal inflammation, No signs of irreversible pulpitis and pulp exposure after excavation of carious dentin

Indirect Pulp Therapy Technique

First appointment

Tooth is anesthetized and isolation is done with a rubber dam. All the caries except that immediately overlying the pulp is removed. Judicious removal of soft, deep carious dentin, using large round burs, hand excavation, taking care not to produce a pulp exposure. Placement of appropriate lining material such as GIC, hard setting Ca(OH)₂, ZOE, or a directly bonded restoration. Definitive restoration providing good coronal seal. Select a provisional restorative material on the basis of the length of the treatment interval, ranging between 6 and 8 weeks.

Second appointment

Texture should be from wet & spongy to hard. Removal of carious dentin and placement of restoration is done in second step. Interval gap of 3 to 6 months is kept to allow sufficient time for the formation of tertiary dentin and a definitive pulpal diagnosis.

Step-wise Caries Removal^{9,10}

Stepwise excavation is a method of reducing pulpal exposure and pathosis risk by removing the caries lesion in different appointments with ≥ 6 month intervals.

Indications

- Deep dentinal lesions in permanent teeth likely to result in pulp exposure during single excavation
- Clear evidence of pulp vitality and no evidence of irreversible pulpitis
- No history of spontaneous or prolonged pain
- Positive pulp vitality test (electric, thermal, mechanical)
- Negative to percussion/palpation
- Radiographically: $>75\%$ through dentin and no periradicular pathosis
- Reliable patient – controls and follow up in place
- Rapidly progressing lesions in a closed cavity environment

1st STAGE: Selective removal to soft dentine

Stepwise procedure is planned and discussed with patient before beginning any irreversible treatment. Use rubber dam isolation. Stage 1 has the same caries removal aims as selective removal to soft dentin. Periphery of the cavity should be hard with a clean DEJ resulting in a 1-1.5mm wide zone of sound/hard dentin. Centrally (pulpal/axial) perform selective removal to soft dentin, but there should be enough removal of carious tooth tissue to place a durable provisional restoration while still avoiding pulp exposure. Undermined enamel can remain at this stage for retention of glass ionomer. Good sealing with materials that enhance the dentin's potential to remineralize are recommended. Providing a good seal is critical for arresting caries progression. (FDI Policy statement, October

2001). Material of choice: Glass Ionomer (Conventional or RMGI). PINK Fuji VII (Triage) GIC is used as the initial layer directly over and only over the remaining leathery wet dentin as a visual identifier and on the top Fuji IX or Fuji II LC is placed for functional and esthetic purposes. Check occlusion afterwards. Then clear and complete information should be recorded in the HER. Re-evaluation/ re-entry after ≥ 6 months

2nd STAGE: 6 -12 months later, selective removal to firm dentin

Periradicular pathosis is evaluated by new periapical radiograph. Evaluate for symptoms or signs of a possible pulp pathosis, sensibility/vitality test MUST be confirmed. Remove provisional restoration taking caution to not exposure the pulp. Perform selective removal to firm dentin centrally (complete removal of pink Fuji Triage may not be required to achieve this objective). Place final restoration as indicated with appropriate material specific modifications to the preparation. After every 6 months, Follow up is done with vitality testing and periapical radiographs.

Direct Pulp Capping^{8,11}

If a material is placed directly over the exposed pulp tissue, it has been suggested as a way to promote pulp healing and generate reparative dentin.

Indications: Asymptomatic vital tooth (Pin-point exposure (0.5mm or less in diameter), Non-hemorrhagic or easily controlled and dry, sterile field

Factors of importance for successful outcome

Larger the area of carious exposure the poorer the prognosis for pulp capping. With a larger exposure more pulpal tissue is inflamed and there is a greater chance for contamination by microorganisms. There is also greater chance from crushing of tissues and hemorrhage, causing a more severe inflammation .However when exposure occurs as a result of traumatic or mechanical injury to a healthy pulp the size of the exposure does not influence healing.

Location of pulp exposure may be an important consideration in the prognosis .if the exposure is on the axial wall and the remaining pulp tissue coronal to the exposure site is deprived of its blood supply, it will undergo necrosis, in such cases pulpotomy or pulpectomy should be performed rather than a pulp cap .

Direct Pulp Capping Techniques^{12,13}

1. Calcium hydroxide technique: Hemostasis followed by disinfection of cavity placement of calcium hydroxide and then RMGIC followed by IRM or restoration
- 2) Total etch technique: Hemostasis followed by disinfection of cavity placement of primers and adhesives and then RMGIC followed by restoration

Treatment recommendations

Two visit technique

After profound local anesthesia, the tooth is isolated with a dental dam, a caries detector dye is applied .Caries removal is completed with slow-speed carbide round burs and spoon excavators After caries removal, the exposure should be stop hemorrhaging by a

cotton pellet moistened with 3–6% NaOCl which is placed directly against the exposure for a contact time of 1 – 10 min. The MTA is mixed according to the manufacturer's instructions and placed.

One-step pulp capping

Isolation is done using dental dam and complete cavity preparation is done using high-speed burs under constant water cooling. Cotton pellet moistened with NaOCl is used to control bleeding. ProRoot MTA is prepared according to mixing instructions. ProRoot MTA over the exposure is placed using a small ball applicator which is further covered by small amount of Dyract Flow flowable compomer, (or an equivalent light-cured resin, glass ionomer liner) and light cure according to instructions. Etching is done of the remaining cavity walls with 34%–37% phosphoric acid gel for 15 seconds followed by thorough rinsing. A small ball applicator is used and a small amount of ProRoot MTA is applied over the exposure. To cover the ProRoot MTA, small amount of Dyract Flow flowable compomer (or an equivalent light-cured resin, glass ionomer liner) is applied and then light cure according to instructions. Etch the remaining cavity walls with 34%–37% phosphoric acid gel for 15 seconds. Rinse thoroughly.

Pulp capping materials^{14,15}

Calcium Hydroxide

For several decades, it has been considered the “gold standard” of direct pulp capping materials. It has excellent antibacterial properties. High pH of calcium hydroxide is believed to cause irritation of the pulp tissue, which stimulates repair.

Healing with Calcium Hydroxide

Zone of obliteration

Pulp tissue immediately in contact with calcium hydroxide is completely distorted because of the caustic effect of drug. This zone consists of debris, dentinal chips, blood clots and particles of calcium hydroxide.

Zone of coagulation necrosis

A weaker chemical effect reaches subadjacent, more apical tissue and results in zone of coagulation necrosis and thrombosis. This is also called as Stanley's mummified zone and Schroder's layer of firm necrosis.

Line of demarcation

Deepest level of zone of coagulation necrosis and adjacent vital pulp tissue is formed by this line. It is seen that this line is formed by the reaction of calcium hydroxide with tissue proteins to form proteinate globules.

Advantages: Initially bactericidal then bacteriostatic. Promotes healing and repair, High pH stimulates fibroblasts. Neutralizes low pH of acids. Blocking patent dentin tubules, Inexpensive and easy to use.

Disadvantages: Does not exclusively stimulate dentinogenesis and reparative dentin, associated with primary tooth resorption, does not adhere to the dentin or resin restoration, degrade during acid etching, degrades upon tooth flexure, marginal failure with amalgam condensation.

Mineral Trioxide Aggregate (MTA)

MTA forms a very tight seal where it contacts the dentin walls, most likely due to a physical bond between MTA and dentin. With this seal, bacterial penetration to the pulp amputation site is prevented and reduced.

Setting Reaction

On hydration, the MTA powder results in the formation of crystalline gel of the hydrated components of MTA with trace formation of calcium hydroxide. This hydrated mass slowly solidifies to a hard structure in about 3 hours time. For DPC and pulpotomy, MTA can be used as an alternative to calcium hydroxide.

Mechanism of Action

When MTA and water is reacted gives calcium hydroxide is formed which causes cells under it to proliferate, these cells they migrate and elaborate new collagen along the superficial necrotic zone or the pulpal surface of capping material. Necrotic zone along with the new collagen layer attracts mineral salts these become calcified matrices (fibrodentin) the layer of odontoblasts like cells is formed in association with the fibrodentin and reparative dentin is secreted.

Pulpotomy^{16,17}

Pulpotomy is defined as a procedure in which a portion of the exposed coronal vital pulp is surgically removed as a means of preserving the vitality and function of the remaining radicular portion. Inflammatory or degenerative changed pulp tissue is removed, leaving the intact vital tissue, which is then covered with a pulp capping agent to promote healing at the amputation

site or an agent causing fixation of the underlying tissue.

Indications

Mechanical or carious exposure in permanent teeth with incomplete root formation, Traumatic exposures of where coronal pulp is likely to be inflamed in young permanent teeth, Absence of spontaneous pain and swelling or alveolar abscess formation

Contraindications

Patients with irreversible pulpitis, Abnormal sensitivity to heat and cold, Tenderness to percussion, Marked constriction of root canals or calcification, Bi- or trifurcation involvement or the presence of an abscess, Less than 2/3 of root remaining, Unrestorable tooth and Permanent successor close to eruption

Pulpotomy procedures can be divided into two categories on the basis of:

(I) Amount of pulpal tissue remnant

- a) Cervical pulpotomy
- b) Partial pulpotomy (Cvek's pulpotomy)

(II) Action of medicament employed

- a) Materials that provide healing of the pulp: calcium hydroxide
- b) Material that sanitizes and fixes pulp tissue: formocresol

Partial Pulpotomy

The underlying inflamed pulp is removed, and a partial pulpotomy is performed on the remaining healthy pulp with calcium hydroxide. The uninfected vital pulp tissue

can be preserved in the root canal by the surgical excision of the inflamed coronal pulp. The removal of the infected portion of the pulp affords temporary, rapid relief of pulpalgia and further the remaining tissue may undergo repair while completing apexogenesis (root-end development and calcification). It is recommended for crown-fractured teeth with pinpoint exposure and in asymptomatic young permanent tooth with carious exposure.

Cervical Pulpotomy

This involves coronal pulp removal to a level of the root orifices. As much pulp tissue as possible should be left in the root canal to allow maturation of the entire root, rather than just of a portion of it. A partially matured root is weak and susceptible to fracture by occlusal forces. Dressing of pulpotomy agent is placed, Bacteria-tight seal, and coronal restoration are carried out as with partial pulpotomy

Materials used in Pulpotomy^{18,19}

Formocresol

Sweet (1930) introduced the multiple visit formocresol technique. Administer local anesthesia isolate tooth with rubber dam remove caries and determine site of pulp exposure remove roof of pulp chamber remove coronal pulp with large excavator or large round bur, apply FC on a pledget of cotton wool for 4 minutes, remove pledget after 4 minutes and check that haemorrhage has stopped. Fill pulp chamber with cement and restore tooth with SSC.

Glutaraldehyde

Glutaraldehyde, has been suggested as an alternative to formocresol as pulpotomy agent, based on its superior fixative

properties, low antigenicity and low toxicity. Histologic studies have shown that it produced rapid surface fixation of pulp tissue but with limited depth of fixation, so larger amount of pulp tissue remained vital

Ferric Sulphate Pulpotomy

Prior to application of FS bleeding is controlled. Place ferric sulfate using syringe with cotton tip or apply with cotton pellet for 15 seconds

Electrosurgical Pulpotomy

It is a non-chemical devitalization. Electrocautery carbonizes and heat denatures the pulp and bacterial contamination. When the procedure is properly performed, then the pulp stumps appear black and dry. The chamber is filled with zinc oxide eugenol and tooth is restored with permanent restoration.

Laser Pulpotomy

Jeng-fen Liu et al in 1999 studied the effect of Nd:YAG laser for pulpotomy in primary teeth and noted 100% success with no signs or symptoms, and only one tooth had internal root resorption at the six-month visit. Shoji et al - CO₂ laser Charring, coagulation necrosis & degeneration of the odontoblastic layer occurred although no damage was detected in the radicular portion of the pulp.

Apexogenesis²⁰

It is a vital pulp therapy procedure performed to encourage continued physiological development and formation of the root end in exposed vital teeth with open apex.

Technique:

Access cavity preparation under rubber dam. Pulp tissue resection is done with a small endodontic spoon excavator or round, abrasive diamond bur. Following coronal pulp amputation, the pulp chamber is rinsed with sterile saline or sterile water to remove all debris. Saline-soaked cotton pellets or NaOCl is used to control the bleeding. Calcium hydroxide paste is placed over the amputation site, once the bleeding is controlled. Once this is accomplished, a restorative base material should be placed over the calcium hydroxide and then allowed to set complete. A coronal restoration should then be placed that will ensure the maximum long-term seal. In the first year, patient should be re-evaluated every three months and then every 6 months for 2 to 4 years for the determination of successful root formation absence of signs of pulp necrosis, root resorption or periradicular pathosis.

Apexification^{20,21}

Apexification is the process of creating an environment within the canal and periapical tissues after pulp death that allows a calcified barrier to form across the open apex of an immature root. Calcium hydroxide alone or in combination with other drugs is widely accepted to promote apexification. The calcium hydroxide powder has been mixed with CMCP, Cresanol, saline, distilled water, and anesthetic solution. The most important factors in achieving apexification seem to be thorough debridement of the root canal (to remove all necrotic pulp tissue) and sealing of the tooth (to prevent the ingress of bacteria and substrate).

If symptoms persist or any signs of infection are present at a subsequent appointment or if the canal cannot be dried, the debridement phase is repeated and the canal is medicated with a slurry of calcium hydroxide paste and sealed. When the tooth is free of signs and symptoms of infection, the canal is dried and filled with a stiff mix of calcium hydroxide and CMCP.

The procedure is usually performed without the use of local anesthetic. This is preferable if possible so that the patient's response can be used to indicate the approach to the apical foramen. The paste may be carried into the canal with an amalgam carrier, lentulo spiral, disposable syringe, or endodontic pressure syringe. Pluggers are helpful for packing the material to the apex. Radiographic checks of the depth of the filling are essential to verify an adequate filling. Seal the tooth with permanent restoration.

Periodic Recall: The usual time required to achieve apexification is 6 to 24 months (average 1 year \pm 7 months). During this time the patient is recalled in 3 month interval for monitoring of the tooth. If any signs or symptoms of reinfection or pathology occur during this phase of treatment the canal is recleaned and refilled with the calcium hydroxide paste. The patient is retained until radiographic evidence of apexification has become apparent then the tooth is reentered and clinical verification of apexification is checked by the failure of a small instrument to penetrate through the apex.

Obturation With Gutta-percha: After verification of successful apexification, the canal is thoroughly cleaned, care being taken not to damage the calcific barrier at the apex. The canal is then obturated with

guttapercha in the usual manner. Because of the large size of the canal, it may be necessary to prepare a customized gutta-percha point.

CONCLUSION

Dental caries is the most common problem in dentistry. Every problem in dental starts from carious lesion and progresses to pulpal pathosis. If controlled earlier then can be treated appropriately. Deep carious lesion should be managed properly with various procedures like pulpotomy, pulp capping so that root canal treatment can be prevented. Patient education and motivation in the prevention and treatment of caries must be stressed. Finally the clinical treatment of cavitated, carious teeth must be accomplished expeditiously, judiciously and appropriately.

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