Operative Dentistry

Pulp Capping Materials

Many researchers though that the pulp capping materials should have the following ideal properties:

1. Stimulate reparative dentin formation.
2. Maintain pulp vitality.
3. Adhere to restorative material and dentin.
4. Sterile
5. Provide bacterial seal.
6. Radiopaque

Some publications suggested many materials developed for pulp capping therapy such as; zinc oxide-eugenol, ledermix, calcium hydroxide, hydroxyapatite, B-tricalcium phosphate, allogenic dentin matric, bone morphogenic protein, CO2 laser, dentin bonding agent, MTA, Biodentine, and TheraCal.

I. Calcium hydroxide (Dycal):

Calcium hydroxide is the most popular agent for direct and indirect pulp capping and maintaining pulp vitality, given its ability to release hydroxyl (OH) and calcium (Ca) ions upon dissolution. Both clinically and histologically it has been found to produce satisfactory results in indirect and direct pulp capping, because it can stimulate the formation of tertiary dentin by the pulp. This material also probably can stimulate or enhance the remineralization process when it applied directly on the carious or demineralized area. Currently, calcium hydroxide products are the best documented and most reliable materials for direct pulp capping and serve as the "gold standard" against new tested materials.

The short coming for the use of Ca(OH)2 are:

1. Ca(OH)2 will break down when acid etchants are used.
2. Absorption: it will be dissolved after long term restoration placement.

3. Mechanical instability: there will be interfacial failure during amalgam condensation.
4. There will be a tunnel defects in reparative dentine that remain open from the pulp to the medicament interface, allowing recurrent microleakage of bacteria to the pulp.

Visible Light Cure (VLC) Dycal

Another version, one hard setting Ca(OH)2 material has been developed, which is a visible light activated Dycal. Its polymerization is done with visible light in the blue end of spectrum for 40 seconds. It has the major advantage of a conventional viscosity for placement thus enabling the operator to position the Ca(OH)2 on the pulp exposure and position it evenly over the surrounding dentin before choosing the moment to harden the material by applying the polymerization light. However, it has been reported that the degree of calcium ion release, combined with definite antimicrobial properties for light cured calcium hydroxide is lower than that of the conventional chemically set calcium hydroxide.

Mode of action of calcium hydroxide in pulp capping: -

1- Antibacterial action, this can minimize or eliminate bacterial penetration to the pulp. Besides it can neutralize the acidic bacterial byproducts due to its high pH value (11-12).

2- Reparative dentin formation, calcium hydroxide produces coagulation necrosis of the surface of the pulp, and directly under this, the underlining tissue differentiates into odontoblasts, which then elaborate a matrix in about 4 weeks, this may be caused by its irritating quality due to high alkalinity pH. In addition to that calcium hydroxide has the capacity to mobilize growth factors from the dentin matrix, causing the formation of new dentin.

3-Remineralization, calcium hydroxide may be involved in the remineralization of carious dentin. This is not fully understood, which might be related to the ability to release calcium ion and initiate or enhance the remineralization process.

II. Mineral trioxide aggregate (MTA)

Mineral trioxide aggregate is a biocompatible material with numerous exciting clinical applications. MTA has been used in both surgical and non-surgical application including direct pulp capping, perforation repair in root and apexification.

MTA is supplied as a gray or white powder consists of fine hydrophilic particles of Tricalcium silicate, Tricalcium aluminate, Tricalcium oxide and silicate oxide. Bismuth oxide powder has been added to make aggregate radioopaque. The manufacturer recommends that it be mixed with sterile water into a thick, grainy paste.

Advantages and potential mechanism of action of MTA are similar to Ca(OH)2, including its antibacterial and biocompatibility properties, high pH of 12.5 after setting, and its ability to aid in the release of bioactive dentin matrix protein.

Significant disadvantages of self-cure MTA include the slow-setting times from several minutes to hours, technique sensitive and high cost per use. As a result, two-step procedures are frequently necessary requiring interim restorations. Recent evidence indicates that an indirect pulp cap can be performed in a single treatment appointment.

III. Biodentine:

Biodentine is new bioactive cement with dentin-like mechanical properties, which can be used as a dentin substitute on crowns and roots. It has a positive effect on vital pulp cells and stimulates tertiary dentin formation. In direct contact with vital pulp tissue it also promotes the formation of reparative dentin.

Biodentine consists of a powder and liquid in a capsule. The powder mainly contains tricalcium and dicalcium silicate, the principal component of Portland cement, as well as calcium carbonate. Zirconium dioxide serves as contrast medium.

The liquid consists of calcium chloride in aqueous solution with an admixture of polycarboxylate. The powder is mixed with the liquid in a capsule in the triturator for 30 seconds. Once mixed, Biodentine sets in about 12 minutes. During the setting of the cement calcium hydroxide is formed. The consistency of Biodentine reminds of that of phosphate cement.

Biodentine can be used both on crowns and roots. Its crown uses include pulp protection, temporary closure, deep caries management, cervical filling, direct and indirect pulp capping and pulpotomy.

On the roots, it has a place in managing perforations of root canals or the pulp floor, internal and external resorption, apexification and retrograde root canal obturation i.e. the formation of reactive or reparative (tertiary) dentin.

IV. CO2 Laser

CO2 laser has been shown to increase success rate of pulp capping process. In literature, the success rate was 89% in the laser group that treated with Co2 laser plus calcium hydroxide application on the conventional pulp capping technique (68%).
The most important effects of laser irradiation seem to be sterilization and scar formation in the irradiation area due to the thermal effect, which may help to preserve the pulp from bacterial invasion. Another effect of laser treatment might be direct stimulation of dentin formation as indicated by one study using super pulsed CO2 laser instead of the continuous wave to prevent significant temperature rises at the pulp tissue.

V. **Theracal LC. : (Resin-Modified Calcium Silicate)**

TheraCal LC is a light-cured, resin-modified calcium silicate. Its unique apatite stimulating ability makes it ideal for direct and indirect pulp capping and as a protective base/liner under composites, amalgams, cements and other base materials. It can be used as an alternative to calcium hydroxide, glass ionomer, RMGI, IRM/ZOE and other restorative materials. TheraCal LC performs as a barrier and protectant of the dental pulpal complex.

It could release calcium stimulates hydroxy apatite formation, also significant calcium release leads to protective seal, whereas the alkaline pH promotes healing in addition to apatite formation. It can form a protective barrier that insulates the pulp and it is a highly radiopaque material.

Ledermix:

Ledermix is a mixture of triamcinolone acetonide (asteroid) and dimethylchlortetracycline in water soluble base. It has anti-inflammatory and bacteriostatic properties, but it results in a rapid spread of bacteria not affected by the antibiotic it contains. It is a useful compromise for the management of irreversible inflamed pulps where anesthesia may be a problem or when pulp exterbation has to be delayed.

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