

## REVIEW ARTICLE

# RECENT ADVANCEMENTS OF INDIRECT PULP CAPPING IN PRIMARY TEETH: A REVIEW

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### ABSTRACT:

Indirect pulp treatment is a procedure performed in a tooth with a deep carious lesion approximating the pulp but without signs or symptoms of pulp degeneration. In recent time vital-pulp therapy has been greatly enhanced with the introduction of various pulp capping materials. The main objective of this article is to discuss about the various advanced pulp capping materials used for protection of the dentin-pulp complex.

Keywords: Indirect pulp capping, Pulp capping agent, Reparative dentin.

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**I**NTRODUCTION  
Preservation of the integrity of primary dentition is the most important aspect of pediatric dentistry. Nothing is more valuable than preservation of the primary tooth, which reflects the general health of the child patients. Dental caries is the most common cause for the premature loss of primary teeth<sup>1</sup>. The purpose of deciduous tooth pulp therapy is to preserve it until their natural exfoliation. It is essential for the proper growth of facial and skeletal complex. For obtaining excellent results in pulp capping careful selection of tooth is very important. In view of new insights into primary pulp biology, developments in pulpal medicaments and worldwide changes in clinical practice, it was felt necessary to update the previous Clinical Guideline on pulp treatment for the primary dentition<sup>2</sup>. Recent reports showed favorable outcome with recent materials because in cases pulp is inflamed was still vital and so still maintained a blood supply which is important for healing phenomenon.

### DISCUSSION

"Indirect pulp treatment is a procedure performed in a tooth with a deep carious lesion approximating the pulp but without signs or symptoms of pulp degeneration. The caries surrounding the pulp is left

in place to avoid pulp exposure and is covered with a biocompatible material."

The objective is to reduce the number of bacteria, and to slow or arrest the caries development. It is based on the theory that a zone of affected, demineralized dentin exist between the outer infected layer of dentine and the pulp. Although carious dentine left in the tooth probably contains some bacteria, the number of organisms can be greatly diminished when this layer is covered with ZOE or Calcium Hydroxide. The rate of reparative dentine formation is 1.4um/day after cavity preparation. The decreases markedly after 48hrs. Indirect pulp capping indicated in the treatment of deep carious lesion without pulp involvement and no signs of lymphadenopathy<sup>3</sup>. Normal color of tooth and absence of mobility should be there. In Radiographic examination, there should be no radiolucency at the apices of the roots or in the furcation. Lamina Dura should be intact with normal periodontal ligament space. Indirect pulp capping is contraindicated in the patients with sharp, spontaneous, penetrating and prolonged spontaneous pain particular in night. Presence of mobility, discoloration of tooth, Negative electric pulp test are the other contraindication of indirect pulp capping<sup>4</sup>.

The clinical procedure involves Good isolation with rubber dam, Removal of all caries at the enamel-

dentine junction followed by judicious removal of soft deep carious dentine (using hand excavators or a slowly rotating large round steel bur) lying directly over the pulp region with care to avoid a pulpal exposure. Placement of appropriate lining material such as a reinforced glass ionomer cement, a hard-setting calcium hydroxide or zinc oxide eugenol. Definitive restoration to achieve optimum external coronal seal.<sup>5</sup>

## MATERIALS USED

Earlier contemporary materials were used in indirect pulp capping such as zinc oxide eugenol, calcium hydroxide, mineral trioxide aggregate etc. With the advancement in material sciences, various new materials had evolved in Pedodontics.

- 1) **Biodentine-** It is new bioactive cement having dentin-like mechanical properties. It can be used as a dentine substitute on crowns and roots. It stimulates tertiary dentin formation and has a positive effect on viable pulp tissue. Due to its improved material properties, it becomes an interesting alternative to conventional calcium hydroxide-based materials. It has capacity of tissue regeneration and mineralization. It is a biocompatible material with high bonding strength and good material handling. It has strong antibacterial action with excellent marginal adaptability. It is used in the crown for temporary enamel restoration, Permanent dentin restoration, Deep or large carious lesion, Deep cervical or residual lesion, Pulp capping or Pulpotomy, Internal or external resorption, Retrograde surgical filling, as dentine substitute for posterior restoration, Repair of root perforation, apexification.<sup>6</sup>

Lauren et al (2010)<sup>7</sup>, on the biological level, it is perfectly biocompatible and capable of inducing the apposition of reactionary dentin by stimulating odontoblasts activity and reparative dentin, by induction of cell differentiation.

Priyalakshmi.S, Manish Ranjan said that biodentine to be keyed to the dentine by means of innumerable microscopic cones, creating a stable anchorage with a sealing, bacteria-tight effect. Biodentine has various advantages such as it can be used in Deep or large carious lesion, Deep cervical or residual lesion. It is also used as a restorative material in Permanent dentin restoration, Repair of root perforation and apexification. But the Disadvantages of this materials are its high cost and is not indicated for root caries.<sup>8</sup>

- 2) **Stem cells-** Stem cells are a group of undifferentiated biological cells which are capable of both self-renewal and multilineage. Stem cells are competent in renewing themselves for long periods. Stem cells have potential to give rise to tertiary dentine, which is therapeutically used for indirect pulp capping.<sup>9</sup>

There are various types of dental stem cells- Dental pulp stem cells, Dental pulp of human exfoliated deciduous teeth, Stem cells of apical papilla, Dental follicle progenitor cells, and Bone marrow-derived mesenchymal stem cells. Rajgopal L A recent study demonstrates de novo regeneration of dental pulp in emptied root canal space using dental stem pulp.<sup>10</sup>

Stem cells are very beneficial in terms of therapeutic cloning and regeneration medicine. It provide great potential for discovering and cures to a plethora of disease including Parkinson's disease, schizophrenia, Alzheimer's disease, spinal cord injuries, diabetes and many others. With the help of regenerated pulp a damaged tooth can re-built from inside with proprioceptive function of tooth. But the Disadvantages of stem cells are destruction of blastocytes is needed for the use of embryo stem cells. It is also completely unknown what the long term effects of such an interference. These are derived from embryos that are not patients own and the patient's body may reject them.

- 3) **Propolis-** Propolis is a natural derivative with biological and pharmacological properties. Extensively used as a pulp capping material in human teeth. It is a honey bee product which is resinous in nature and has been used as a traditional anti-inflammatory and anti-bacterial medicine. The main ingredients in propolis are alcohols, aldehydes, aliphatic acids& esters, amino acids, ketons, sugars and other<sup>11</sup>.

In a study by Grange and Davey, they used a Propolis dilution of 1:20 in nutrient agar which completely inhibited the growth of *S. aureus*, *S.epidermidis*, *Enterococcus* spp. *Corynebacterium* spp. *B. catarrhalis* and *B. cereus*. This dilution partially inhibited the growth of *P. aeruginosa* and *E. coli* but had no effect on *K. pneumoniae*.<sup>12</sup>

Lonita et al used a paste made from an alcoholic solution of Propolis and zinc oxide. The study included 150 teeth with indirect pulp

capping of deep cavities and 50 teeth with direct pulp capping. The results obtained showed that the paste with Propolis exerted effects similar to those of zinc eugenol<sup>13</sup>. Propolis has a great potential to work as a pulp capping agent. It can also be used as an antimicrobial agent in the treatment of periodontal diseases and dental caries. In pulpal infections, it acts as a tissue repairing agent and also helps in wound healing after surgical procedures. It can be used as an antioxidant and it is also effective in treatment of cancer. It also reduces hypersensitivity. But it shows mild to moderate inflammation after 2-4 weeks with partial dentin formation.

- 4) **Theracal LC-** It is a Radio-opaque, light cured, resin modified calcium silicate filled liner. It is designed for use in indirect and direct pulp capping, as a protective base/liner under composites, amalgams, cements, and other base materials. It acts as an insulating cover and protect dentine-pulp complex so reduces dentine hypersensitivity. It consists of tricalcium silicate particles which provides calcium release. Because of this its stability and durability increases.<sup>14</sup>  
Gandolfi et al., compared chemico-physical properties of TheraCal, ProRoot MTA and Dycal and concluded that TheraCal displayed higher calcium releasing ability and lower solubility than either ProRoot MTA or Dycal.<sup>15</sup> Desai S Schendler N concluded in his study that it act as a barrier to protect the pulp, which may induce the formation of new dentine bridge between the pulp and restorative material. The theracal Used as a liner over the deepest part of preparation i.e. nearest to the pulp. It can be used as a replacement for calcium hydroxide, glass ionomer, resin modified glass ionomer, zinc oxide eugenol and other restorative materials. It has strong physical properties and low solubility<sup>16</sup> Drawback of this material is its opaque and whitish color; so it should be kept thin, so as not to show through composite materials that are very translucent affecting final restoration shading.

5) **Castor Oil Bean Cement**

The castor oil bean (*Ricinus communis*) is polyester formed by an amino radical, which confers bactericidal effect and has biocompatibility with living tissues. It consists

of 8-96% of triglycerides of ricinolic acid.<sup>17</sup> It was originally developed as a biomaterial for bone repair and regeneration after local bone damage. Due to these positive characteristics, the material is considered to be an excellent candidate for use in pulp capping. It also has high antibacterial effect and low cytotoxicity. Inflammatory responses are less with this material. It also has better sealing ability and low cost. But it is bio inert rather than bioactive.<sup>18</sup>

- 6) **Emdogain-** Emdogain is a rich amelogenin and amelin protein that are capable of inducing a reparative process. During tooth development source of enamel matrix derivative proteins is hertwig's epithelial root sheath. Emdogain helps in regeneration by PDL regeneration. Biomolecular proteins like materials also present in Emdogain which promote reparative dentine formation.<sup>19</sup>  
Kaida H, Hamachi T (2008) found Emdogain suppresses the inflammatory cytokine production by immunocytes and contains Transforming Growth Factors-β like molecules Nakamura Y et al., concluded that amount of hard tissue formed in Emdogain treated teeth was more than twice that of the calcium hydroxide treated control teeth.<sup>20</sup>  
Al-Hezaimi K stated that, mineral trioxide aggregate produced a better quality reparative hard tissue response with the adjunctive use of Emdogain compared with calcium hydroxide. Emdogain can induce reparative dentin formation and also suppresses the inflammatory cytokine production. Amount of hard tissue formed in Emdogain treated teeth was twice that of the calcium hydroxide. It causes less postoperative symptoms. It has some drawbacks like Emdogain gel when applied on exposed pulps without the adjunctive use of a pulp-capping material was proven to be ineffective in producing a hard tissue barrier because of its poor sealing qualities.<sup>21</sup>

- 7) **Novel Endodontic Cement-** A novel endodontic material called Calcium enriched mixture also known as new endodontic cement was introduced to dentistry by Asgary et al. in 2006. It is a water based tooth colored white powder consisting of hydroxyapatite particles. It has high pH due to this calcium ions which are released from this reacts with endogenous

phosphate creates a colloidal gel which solidifies and form hydroxyapatite.

Novel Endodontic Cement consists of calcium oxide, calcium phosphate, calcium carbonate, calcium silicate, calcium sulfate, and calcium chloride.<sup>22</sup>

Some authors says that wetting of dentinal wall increases because of saliva which facilitate the adaptation of calcium enriched material in the irregularities of root canal wall.

Asgary s et al 2008 showed in his study that the biocompatibility of calcium enriched mixture is similar to calcium hydroxide. He also used it against candida albicans and concluded that it is effective against it.<sup>22</sup>

Mohammad Hassan Zarabi evaluated mineral trioxide aggregate and Novel Endodontic Cement histologically in human dental pulp and concluded that Novel Endodontic Cement induced a thicker dentinal bridge with less pulp inflammation. It is a biocompatible material with Shorter setting time. It is quite economical. It provides ease to handle and creates less micro leakage. It has better flow, good sealing ability and produce less film thickness. It also has ability to form hydroxyapatite and to induce cementum formation. It has both antibacterial and antifungal effect. But further assessment is required for evaluation of pulp response to this material in inflamed pulp.<sup>24</sup>

- 8) **Lasers-**Occurrence of microleakage is common phenomenon seen in deep bacterial lesion with large restorations because of bacterial infiltration. For removal of these large restorations electric drill at low speed is used. Use of electric drill causes less thermal damage, which is less traumatic to tooth. Lasers have stimulatory effect on collagen production and fibroblast proliferation. It also reduces inflammation and pain. Several studies shows that if a low level laser therapy is used, prognosis of indirect pulp capping increases. CO<sub>2</sub> laser and ND-YAG mainly used of indirect pulp capping.<sup>25</sup>

Melcer et al showed that CO<sub>2</sub>laser produced new mineralised dentine formation without cellular modification of pulpal tissue. Hydroxyapatite of enamel and dentine absorbed the energy of 9.6μm CO<sub>2</sub>laser and causes tissue ablation, melting and resolidification.<sup>26</sup>

CO<sub>2</sub>laser reduced dental hypersensitivity by occluding or narrowing the dentinal tubules.

ND-YAG laser with low level energy ie 1w, a 10- Hz repetition rate and an overall 10sec exposure did not cause any damage to pulpal tissue.

Yasuda Y, et al. conducted a study to examine the effect of CO<sub>2</sub> laser irradiation on mineralization in dental pulp cells in rats and mineralization in dental pulp cells is stimulated by CO<sub>2</sub> laser irradiation. Lasers can be used for the secondary dentine formation. It is capable of sterilization of targeted tissue and also has bactericidal nature. It is less time consuming. But it is technique sensitive and can cause thermal damage to pulp in high doses.<sup>27</sup>

- 9) **Endo sequence root repair material-** it consists of calcium silicates, monobasic calcium phosphate, zirconium oxide, tantalum oxide, proprietary fillers and thickening agents. It is a ready to use, premixed bioceramic material.<sup>12</sup>

Hirschman et al concluded in his study that ERRP are less cytotoxic than MTA, Dycal and ultra-blend plus (light curable Ca(OH)<sub>2</sub>).it has good antibacterial effect and less cytotoxicity. But sometimes bioactivity of cells were decreased when exposed to ERM.<sup>28</sup>

**CONCLUSION:** With the clinical success of many primary tooth pulp treatments is reportedly high, studies often demonstrate a much lower proportion of teeth with radiographic signs of complete healing. If the pedodontist properly selects the case, obtains hemostasis, disinfects the exposure, cavity preparation and adequately seals the exposure, success can be obtained. In indirect pulp capping it must be realized that these recommendations are not absolute and will continue to be modified. Regular clinical and radiographic review following any primary molar pulp therapy is strongly recommended. Further researches are required to extend the future scope of this procedure.

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