

# DIRECT PULP CAPPING

## Best choice for direct pulp capping



### BACKGROUND

Direct pulp capping involves the application of biocompatible materials in exposed pulp tissue to seal the opening and provide a barrier to microorganisms and further trauma. The pulp may have been exposed through iatrogenic means, by instrumentation, by deep caries, or by dental trauma. Although the dental pulp has the capacity for tissue repair, the application of biocompatible materials protects the pulp complex and preserves that repair potential. The desirable characteristics of materials for direct pulp capping include antibacterial capacity and properties that induce tissue healing, cytocompatibility, and the ability to seal the lesion. The intervention is designed to induce the differentiation of odontoblast-like cells and tertiary dentin formation in the exposed areas, along with tissue structure reorganization. A systematic review with meta-analysis was carried out to determine which biomaterial or pulp capping therapy is the best choice for preserving the vitality of pulp tissues in permanent teeth with exposed pulps.

### METHODS

The PubMed, Cochrane, and Embase databases were searched for articles published between January 1, 1980 and August 31, 2017 that compared biomaterials and methods used for direct pulp capping. A total of 46 studies were included in the systematic review, with 22 studies comparing mineral trioxide aggregate (MTA) cement and calcium hydroxide (CaOH) cement, tricalcium silicate cement and MTA cement, adhesive systems and CaOH cement, or other materials and techniques. The comparisons focused on the ability of these materials and methods to accomplish a good success rate, inflammatory response, and dentin bridge formation.

### RESULTS

#### MTA Cement vs CaOH Cement

Eleven randomized controlled trials (RCTs) covering 769 teeth in patients age 6 to 60 years lasted between 30 and 1140 days. The success rate was evaluated in 3 RCTs, finding that MTA achieved rates of 80.3% to 100% (mean 91.1%) and CaOH achieved rates from 69.5% to 96% (mean 85.15%). The intense inflammatory response for MTA cement ranged from 0% to 80% (mean 33.68%) and for CaOH cement ranged from 21.4% to 100% (mean 64.77%). Dentin bridge formation occurred in 33.3% to 100% (mean 74%) of teeth treated with MTA cement and 0% to 80% (mean 51.44%) of those treated with CaOH cement.

Eight cohort studies (CSs) covered 30 to 1853 teeth in patients age 7 to 85 years. Over the 360 to 3780 days, the success rate for MTA cement ranged from 61% to 97.96% (mean 83.62%),

but for CaOH cement it ranged from 19.8% to 82% (average 55.20%). When stated, the response rates were between 13.4% and 92.5%. Patient age and type and material of the final restoration were sometimes considered influential in the prognosis.

#### Tricalcium Silicate Cement vs MTA Cement

In 5 RCTs covering 196 teeth in patients age 15 to 79 years, the response rate was more than 93.1%. Success rate was 83% to 100% (average 91.3%) for tricalcium silicate cement, with rates of 86.9% to 100% (average 94.1%) for MTA cements. For tricalcium silicates, intense inflammatory response occurred in 9% to 12.5% (mean 10.7%), whereas for MTA, this response occurred in 9% to 25% (mean 17%). With tricalcium silicate cements the dentin bridge was completely edged in 27.3% to 63.7% (mean 47%) of teeth. With MTA cements, this was achieved in 18.2% to 63.7% (mean 35.6%) of teeth.

#### Adhesive Systems vs CaOH Cements

The 10 RCTs comparing adhesive systems and CaOH cements covered 374 teeth in patients age 11 to 30 years. Success rates for the adhesive systems were between 80% and 100%; the rate for CaOH cements was 100%. Intense inflammatory response occurred in 0% to 100% (mean 41.6%) of those treated with adhesive systems and from 0% to 20% (mean 7.4%) of those treated with CaOH cements. CaOH systems accomplished hard tissue formation in 0% to 100% (mean 70.3%) of teeth, but adhesive systems had no hard tissue formation. However, the adhesive systems were associated with an absence of type 3 collagen and fibronectin, whereas the CaOH cements demonstrated an increase in the expression of these proteins over time.

#### Other Materials and Techniques

Twelve RCTs covering 665 teeth in patients age 11 to 68 years demonstrated that laser treatment had a success rate from 75% to 100% (mean 87.7%). Hydroxyapatite achieved a relatively intense inflammatory response in 0% to 77.8% of teeth and a completely formed dentin bridge in 0% to 80%. Enamel morphogenetic proteins had an inflammatory response in 45.5% to 100% of teeth, and corticoid/antibiotic-based products had a 100% response. No hard tissue formation occurred in the exposure zone treated with enamel morphogenetic proteins. The dentin bridge formation was 100% with natural extracellular matrix. Dentin sialoprotein (DSP) was expressed in teeth treated with enamel morphogenetic proteins when they were applied near the hard tissue barrier and predentin.

## DISCUSSION

MTA cement remains the gold standard for direct pulp capping therapy, although CaOH cement achieves outcomes showing no statistically significant differences from those of MTA. Although tricalcium silicate cements can be recommended as well, studies are needed to evaluate the long-term effectiveness of these materials. The use of laser techniques for direct pulp capping appears to be associated with high levels of success, with a positive effect on the prognosis for teeth treated with this method. Pulp tissue may suffer damage when dental adhesive systems are used, so the use of these materials is not advisable. Other materials that are not advised include hydroxyapatite, enamel morphogenetic proteins, and formulas consisting of antibiotics and corticosteroids.

Paula AB, Laranjo M, Marto C-M, et al: Direct pulp capping: What is the most effective therapy?—Systematic review and meta-analysis. *J Evid Base Pract* 1:298-314, 2018

### Clinical Significance

MTA retains its position as the first choice for direct pulp capping therapy. However, CaOH cement runs a close second and laser techniques are promising, with high rates of success and a good prognosis. Further study is needed to reveal the long-term success rates for tricalcium silicate cements, but they appear to offer promise as well. None of the other methods are advised for direct pulp capping.

Reprints available from AB Paula, Dentistry Area, Biophysics Inst, Faculty of Medicine of Univ of Coimbra, Faculty of Medicine Av Bissaya Barreto, Coimbra, Portugal; e-mail: [anabelabppaula@sapo.pt](mailto:anabelabppaula@sapo.pt)

## Induction of a hard-tissue barrier



### BACKGROUND

Dentin is a physiological barrier protecting the dental pulp from directly interacting with potentially damaging exogenous stimuli. In direct pulp capping and partial pulpotomy, a material is applied directly over the exposed pulp to protect its vitality and avoid more invasive and expensive interventions, such as root canal therapy. Materials used for this procedure include a wide range of products that are designed to promote hard-tissue barrier formation and protect the pulp. Some promote pulpal healing as well. The ability of various commercially available pulp-capping materials to induce hard tissue barrier formation was investigated in a systematic review and meta-analyses.

### METHODS

Both randomized controlled trials (RCTs) and controlled clinical trials were sought through an electronic search of the PubMed, Cochrane, Embase, and Summon databases. In addition, a manual search was conducted of relevant journals and the reference lists of relevant studies. Twenty-seven articles were eligible for the systematic review, with 22 used in 2 meta-analyses. One meta-analysis used 10 articles comparing mineral trioxide aggregate (MTA) and calcium hydroxide (CH); the second meta-analysis used 12 articles that compared bonding agents and CH.

### RESULTS

The greatest number of studies considered MTA and bonding agents for pulp capping. Emdogain gel (EMD) and

Biodentine are capping materials that were compared to MTA and CH for their ability to produce hard-tissue barrier formation.

### MTA and CH

Ten studies compared the hard-tissue barrier formation after pulp capping associated with MTA and CH. CH was used in either powder or cement form. MTA was significantly better than CH in 2 studies and produced a higher proportion of hard-tissue barriers. Positive results were obtained for MTA in 159 of 190 pulp-capping procedures and for CH in 93 of 142 pulp-capping procedures.

### Bonding Agents and CH

Twelve studies compared hard-tissue barrier formation resulting from treatment with bonding agents or CH. CH in these studies was used as a powder, paste, or cement. CH was significantly better than the bonding agents, having positive results in 73 of 93 procedures, whereas the bonding agents had positive results in 11 of 161 procedures. Smaller studies tended to support the use of CH over bonding agents.

### EMD and CH

EMD had less capacity to induce hard-tissue barrier formation and to protect the pulp than CH. However, immunohistochemical evaluation of teeth capped with EMD gel revealed the presence of odontoblast-like cell differentiation and the production of new hard tissue. Longer follow-up may provide additional information about the efficacy of EMD for vital pulp treatments.