

# A new bioactive cement for direct pulp capping

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## Abstract

Biodentine™ is a 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. This prompted its use for direct pulp capping after iatrogenic pulp exposure at tooth 15 in a 22-year-old male patient. First the entire cavity was filled with Biodentine™. Three months later the cement was reduced to a base to replace the dentin layer and a composite filling was placed to replace the enamel layer.

At the follow-up visit at 6 months the tooth was clinically normal and tested positive for sensitivity and negative for percussion. The dental film showed the apical region without any pathological findings.

Due to its improved material properties, Biodentine™ is an interesting alternative to conventional calcium hydroxide-based materials. It offers advantages for direct pulp capping and, in properly selected cases, may contribute to the long-term maintenance of tooth vitality.

**Keywords:** Biodentine, direct pulp capping, maintenance of tooth vitality, pulp, reparative dentin, tertiary dentin

## Introduction

For many decades calcium hydroxide has been the standard material for maintaining pulp vitality. Both clinically and histologically it has been found to produce satisfactory results in indirect and direct pulp capping, because it is capable of stimulating the formation of tertiary dentin by the pulp. In contact with vital pulp tissue it contributes to the formation of reparative dentin, a special variant of tertiary dentin, which seals exposures by newly formed hard tissue. This has been documented by basic research and clinical studies with reported success rates in excess of 80% for direct pulp capping.<sup>1, 2</sup>

Currently, calcium hydroxide products are the best documented and most reliable materials for direct pulp capping and serve as the 'gold standard' against which new materials have to be tested.<sup>3</sup>

Nevertheless, calcium hydroxide has some drawbacks. Poor bonding to dentin, material resorption and mechanical instability are among them. As a result, calcium hydroxide does not prevent microleakage in the long run. The porosities ('tunnel defects') of the newly formed hard tissue may act as a portal of entry for microorganisms. These may cause secondary inflammation of the pulp tissue and are thought to be responsible for failed maintenance of tooth vitality. In addition, the high pH (12.5) of calcium hydroxide suspensions causes liquefaction necrosis at the surface of the pulp tissue.<sup>1</sup>

A new bioactive cement, Biodentine™ (Septodont, St. Maur-des-Fossés, France), was recently launched in the dental market as a dentin substitute. It shares both its indications and mode of action with calcium hydroxide, but does not have its

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disadvantages. Biodentine™ consists of a powder in a capsule and liquid in a pipette. 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 approximately 12 minutes. Calcium hydroxide is formed during the setting of the cement. The consistency of Biodentine™ is similar to that of phosphate cement.

Biodentine™ can be used on both crowns and roots. Its crown applications include pulp protection, temporary closure, deep caries management, cervical filling, direct and indirect pulp capping and pulpotomy. Its use in roots includes managing perforations of root canals or the pulp floor, internal and external resorption, apexification and retrograde root canal obturation.

In summary, Biodentine™ is both a dentin substitute base and a cement for maintaining pulp vitality and stimulating hard tissue formation, i.e. the formation of reactive or reparative (tertiary) dentin.

The following case report illustrates the use of Biodentine™ for direct pulp capping.

### Case report

Four years ago a male patient, then 18 years old, came for a routine check-up. Bitewing films recorded during the diagnostic assessment showed signs of an approximal carious lesion distally on tooth 15 (Figure 1). The patient was informed about the need to have the carious lesion treated, but failed to keep the scheduled appointment. At age 22 he returned, complaining of discomfort of tooth 15 on contact with cold food, drinks and air apparently caused by a buccal enamel fracture of the tooth. On examination, a deep approximal carious lesion was found distally. The tooth was tested positive on CO<sub>2</sub> snow sensitivity and negative on percussion. After thorough information of the patient, an anesthetic (Septanest, 1 ml; Septodont, St. Maur-des-Fossés, France) was injected for terminal anesthesia and a rubber dam was put in place. Following cavity preparation the carious dentin was completely excavated. In the process the pulp cavity was exposed iatrogenically at two sites (Figure 2). Clinically the pulp tissue was vital without any major bleeding, so that maintenance of tooth vitality by direct pulp



*Figure 1: Bitewing film of quadrants 1 and 4 of a patient aged 18 years at the time. Note the proximal carious lesion on tooth 15 distally. The patient did not show up at the scheduled appointment for filling.*



*Figure 2: When the patient returned 4 years later, iatrogenic pulp exposure occurred at two sites during complete caries excavation.*



*Figure 3: For filling the cavity and for direct capping with Biodentine™ (Septodont; St. Maur-des-Fossés, France) a matrix band (AutoMatrix; Dentsply-Caulk, Milford, DE, USA) and wedges were put in place.*



**Figure 4:** Biodentine™ was applied to the cavity with cement pluggers using light pressure. Carving instruments were used for occlusal adjustment. Biodentine™ should not be prepared with rotating instruments and should not come into contact with water.



**Figure 5:** After allowing 12 to 15 minutes for Biodentine™ to set the bite was checked. Subsequent polishing of the Biodentine™ filling should be omitted.



**Figure 6:** Three months later the patient returned to have the cavity definitively filled with composite. At this visit the Biodentine™ filling showed marginal material loss.



**Figure 7:** Biodentine™ reduced to a base/dentin substitute level.

capping was decided upon. NaOCl (2.5%) was applied for hemostasis, clearing and disinfecting the cavity. Biodentine™ (Septodont, St. Maur-des-Fossés, France) was chosen for direct pulp capping. Mixed as recommended by the manufacturer, Biodentine™ was applied to the exposed pulp tissue for direct capping and for temporary restoration. After placing a matrix band (AutoMatrix; Dentsply-Caulk, Milford, DE, USA), (Figure 3), the entire cavity was filled with the bioactive cement (Figure 4). About twelve minutes after mixing, when the Biodentine™ had set, occlusion was checked (Figure 5). At the follow-up visit 4 days after direct capping the patient reported some increased cold and warm

sensitivity of tooth 15, but no other subjective symptoms.

Three months after direct capping he returned to have the Biodentine™ filling (Figure 6) partially removed and covered by a composite filling to replace enamel. The symptoms he had originally reported had completely disappeared within a very short time. Tooth 15 was clinically normal and tested positive for sensitivity and negative for percussion. An anesthetic (Septanest, 1 ml; Septodont, St. Maur-des-Fossés, France) was injected for terminal anesthesia and a rubber dam was placed. The Biodentine™ filling was reduced and kept as a base/dentin substitute (Figure 7) and a matrix band as well as wedges (Composi-Tight 3D; Garrison, Spring Lake,



**Figure 8:** Before restoring the cavity with composite a matrix band (Composi-Tight 3D; Garrison, Spring Lake, MI, USA) and wedges were put in place.



**Figure 9:** Cavity filled with composite (Grandio; VOCO, Cuxhaven, Germany).



**Figure 10:** Finalized and polished composite filling.



**Figure 11:** The dental film recorded 6 months after direct capping does not show any pathological findings apical of tooth 15.

MI, USA) were applied (Figure 8). Then the entire cavity was etched with phosphoric acid, and a dentin adhesive (Optibond FL; Kerr, Orange, CA, USA) and a composite (Grandio; VOCO, Cuxhaven, Germany) were applied (Figures 9 and 10). At the follow-up visit 6 months after direct capping, tooth 15 was clinically normal and again tested positive for sensitivity and negative for percussion. The dental film recorded at that time did not show any pathological findings apically (Figure 11).

### Discussion

Biodentine™ was shown to be biocompatible, in that it does not damage pulpal cells in vitro or in vivo, and is capable of

stimulating tertiary dentin formation. Hard tissue formation is seen both after indirect and direct capping with Biodentine™.<sup>4-6</sup> Used for pulp capping, the material offers certain advantages over calcium hydroxide: It is stronger mechanically, less soluble and produces tighter seals.<sup>7</sup> Three major disadvantages of calcium hydroxide, notably material resorption, mechanical instability and the resultant failure of preventing microleakages are therefore avoided.

Compared to other materials such as Mineral Trioxide Aggregate, Biodentine™ handles easily and needs much less time for setting. Unlike other Portland cement-based products, it is sufficiently stable to be used for both for pulp protection and temporary fillings.<sup>7</sup> For this reason, the

manufacturer recommends filling the entire cavity with Biodentine™ in the first application and to reduce it to a base/dentin substitute level in a second visit one week to 6 months later before final restoration. However, it is important to seal the cavity against bacterial invasion in a one-stage procedure to ensure successful capping.<sup>2, 8</sup> While there is extensive evidence documenting that composite fillings are leak-proof, few pertinent data are available for Biodentine™. Another argument against the two-stage procedure recommended by the manufacturer is the uncertain cooperativeness of patients and whether they will keep a second appointment.<sup>9</sup> Add to all this that the inevitable repeated cavity preparation during the second visit exposes the pulp tissue, damaged as it already is by prior direct capping, to more stress. This can be avoided by a single-stage approach. Consequently, studies are underway to find out whether a single-stage procedure is feasible, by applying Biodentine™ for pulp capping or pulp protection and placing a filling such as a composite, for permanent restoration during one visit. When opting for this approach it is, however, important to wait for Biodentine™ to set (about 12 to 15 minutes after mixing) before proceeding with the restorative treatment. Definitive recommendations cannot be made before the results of ongoing studies are available.

Of note, Biodentine™ fillings were found to show marginal material loss at the follow-up visit after 3 months. This may be attributable to incorrect handling. During occlusal adjustment, Biodentine™ should not be prepared with rotating instruments and should not come into contact with water. It should rather be applied into the cavity with cement pluggers using light pressure, and carving instruments should be used for occlusal adjustment. Subsequent polishing of the Biodentine™ filling should be omitted. Excessive pressure or exaggerated trimming and polishing may disrupt the crystalline structure of Biodentine™ with resultant loss of material strength.

It should be remembered that, aside from the choice of the right capping material, one which is biocompatible and capable of stimulating the formation of hard tissue, other factors also play a critical role for direct capping to be successful:<sup>2</sup>

- The pulp tissue should be clear of bacteria or bacterial toxins. In clinical terms, this means that the tooth should be asymptomatic and that pulp bleeding after exposure should be easily and rapidly controllable.

- Meticulous hemostasis is indispensable. Blood clots left at the material – pulp interface can lead to treatment failure.<sup>10</sup> Sodium hypochlorite is an ideal candidate for hemostasis, because it readily controls bleeding, while at the same time disinfecting the cavity.<sup>11</sup>

- Microbial contamination of the pulp tissue during treatment should be meticulously avoided. This is best achieved with a rubber dam when treating on the dentin third close to the pulp, which reliably prevents the invasion of microorganisms from the oral cavity or saliva. Preventing microorganisms from entering the pulp is a key factor for successful direct capping.<sup>12</sup> By contrast, patient age and the size or site of pulp exposure at best play a secondary role or are altogether irrelevant.<sup>2, 7</sup>

It goes without saying that a follow-up time of 6 months is much too short for evaluating the long-term success of a capping material. Problems associated with direct capping tend to occur up to 5 years post treatment. In more than 50% of problem cases direct capping fails within the first two years. Teeth still vital five years after direct capping stand a good chance of retaining their vitality.<sup>8</sup> More long-term clinical studies are, therefore, needed for a definitive evaluation of Biodentine™.

## Conclusion

Biodentine™ is an interesting product, with the potential of making a major contribution to maintaining pulp vitality in patients judiciously selected for direct pulp capping.

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