

Direct pulp capping of carious immature tooth using bioactive material: A case report

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Abstract

The management of deep carious lesions in immature tooth and the preservation of its pulp vitality is a real challenge in daily dental practice. Bioactive cements are of interest to deal with such cases. Our case report describes the immediate management and the follow-up of an extensive carious lesion on an immature first right mandibular molar with pulp exposure by direct pulp capping using Biodentine. A 6-month clinical and radiographic follow up showed that the tooth was vital, with dentine-bridge formation in the pulp chamber with continuous root formation. This procedure allowed the protection of pulp complex, preserving at the same time its functional and biologic activities due to the capacities of Biodentine as an effective pulp capping material to induce pulp cells to form hard tissue. The aim of this article is to discuss through the report of this clinical case, the indications, advantages and disadvantages of different procedures and biomaterials used for direct pulp capping.

Keywords

Biodentine, dentistry, direct pulp capping, permanent immature tooth, tricalcium silicate cement

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Introduction

In many clinical situations, coronal dental pulp can be exposed to the oral environment by several causes like iatrogenic instrumentation, by crown fracture caused by dental trauma or even by deep caries process. Vital pulp therapy (VPT) is defined as a treatment which aims to preserve and maintain pulp tissue that has been compromised but not destroyed. This procedure is particularly interesting with tooth with incomplete root development.

VPT technique can be a direct pulp capping, partial or total pulpotomy. Many factors lead to choose the option of treatment; the main factor is the degree of pulp inflammation and control of hemorrhage.¹⁻³

The treatment of deep carious lesions is especially challenging for dentists. The understanding of the caries process activity and the clinical context (patient's age and state of health, tooth maturity, pulp diagnostic, type of exposure, etc.) can guide the dentist to make the decision in different situations (complete excavation or partial removal, pulp capping, pulpotomy or, in the most extreme cases, pulpectomy).

Direct pulp capping (DPC) is a procedure consisting of the application of a biocompatible material to seal the communication between pulp exposed tissue and oral environment,

protect the pulp complex and preserve its biologic activities. The ultimate goal of capping material has been widely recognized as its capacities to induce pulp cells to form a new hard tissue (dentin bridge) over the pulp exposed area.^{3,4}

The aim of this article is to discuss through the report of a clinical case, the indications, the advantages and disadvantages of different procedures and biomaterials used for DPC.

Clinical case report

An 8-year-old girl, with molar incisor hypomineralization (MIH) syndrome, referred to our department for the management of the first lower right molar. The clinical examination

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Figure 1. Clinical pre-operative view of 4.6 tooth showing a deep caries lesion.

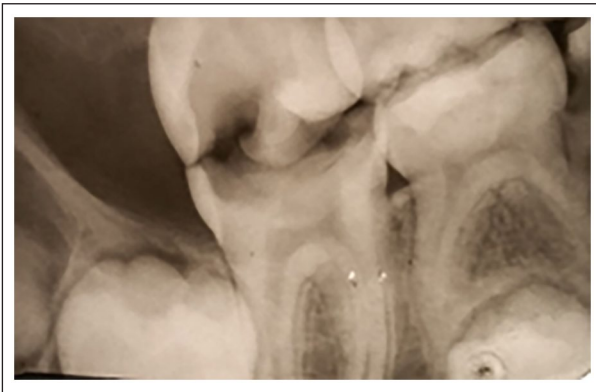


Figure 2. Bitewing X-ray of 4.6 tooth showing the proximity of the lesion to the pulp.

showed a deep carious lesion (Figure 1) with clinical signs of reversible pulpitis (positive response to pulp stimulus).

The bitewing X-ray confirms the proximity of the lesion to the pulp (Figure 2). The proposed treatment plan was indirect pulp capping: complete removal of all infected and affected dentine (with a high risk of pulpal exposure) and to protect the remaining healthy pulp with a bioactive material.

The clinical procedure was as follows:

- Clinical and X-ray investigations (Figures 1 and 2).
- Local anesthesia was administered, and the tooth was isolated with a rubber dam.
- The caries lesion was initially cleaned using a high-speed rotary instrument and then complete caries removal was performed using a slow-speed rotary instrument using a caries detector: Sable™ Seek® Ultradent.
- Before the removal of the last layer of infected dentin from the pulp wall, the cavity was cleaned for 1 min using a cotton ball moistened with 3% sodium hypochlorite. The mechanical cleaning of the pulp

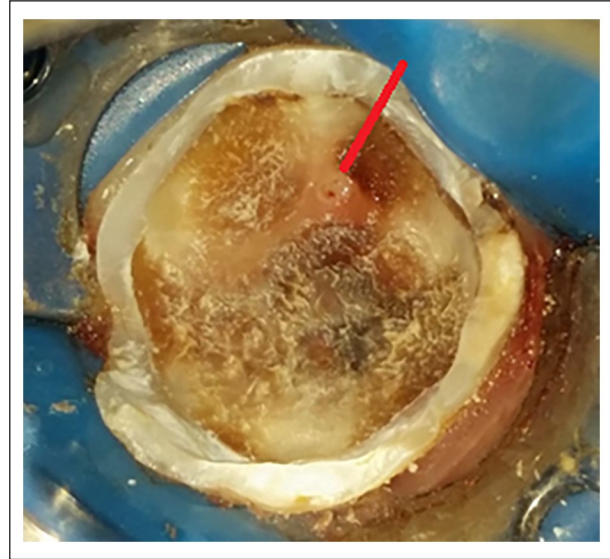


Figure 3. Clinical view after the caries removal showing the pulp exposure (red arrow).

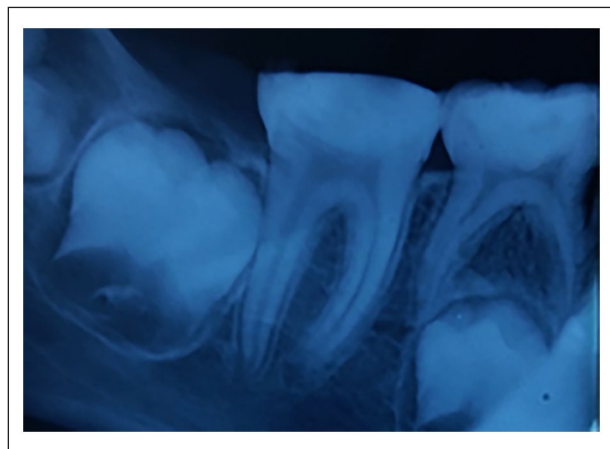


Figure 4. Appearance after the application of Biodentine™.

wall was carried out with an excavator and accidentally pulp tissue was exposed (1.5 mm of diameter) (Figure 3: red arrow). For bleeding control, we applied a cotton ball soaked in physiological saline for 3 min.

- Biodentine™ was applied into the cavity directly over the pulpal exposure, followed by a radiographic control (Figure 4)

Biodentine was used as a temporary coronal filling material for 6 months. Clinical controls were performed at 2 weeks, 1 month, 2 months, and 6 months after treatment. They revealed that the tooth was functional with yellow discoloration and local destruction of the Biodentine™ coronal temporary restoration (Figure 5).

Radiographic examination confirmed complete root development and dentin bridge formation (Figure 6).

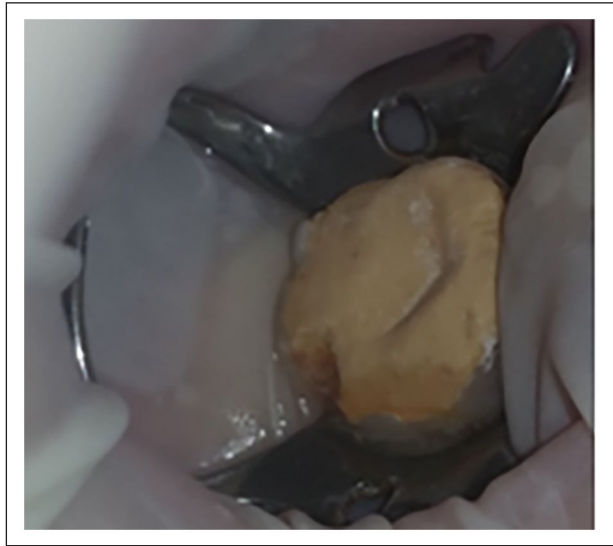


Figure 5. Post-operative photograph.

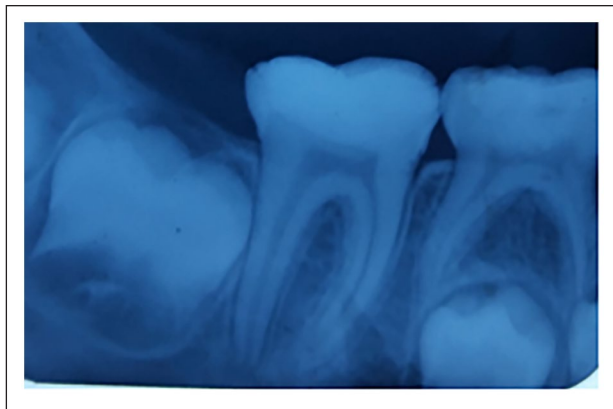


Figure 6. Clinical control at 6 months showing yellow discoloration and local destruction of the Biodentine™ coronal restoration.

At 6-month follow-up appointment, the composite restoration was performed: Biodentine™ was cut back with a dental bur and a thick layer was left in place as a dentin substitute. The etching procedure was carried out using an enamel etchant (Scotchbond™ Etchant 3M™ ESPE™) which was then washed and dried, before an adhesive (Scotchbond™ Universal) was applied, then cured and sealed with a hybrid composite (Filtek Supreme XTE 3M™ ESPE™) using a layering technique (Figure 7).

Discussion

MIH is an enamel defect of systemic origin. After the eruption, the properties of the enamel are altered by increased porosity and decreased hardness giving the permanent tooth less structure resilience. This can lead, especially with poor oral hygiene, to dentin exposing, making the tooth very susceptible to the appearance of deep carious lesions.



Figure 7. X-ray at 6-month follow-up appointment showing dentin bridge formation underneath the Biodentine™, as well as apical closure.

The selection of clinical cases is greatly the keys of success of DPC therapies.⁵ In fact, this treatment is commonly indicated for teeth with normal pulp or reversible pulpitis. It is indicated when the vital pulp is visibly exposed due to trauma, or due to a misadventure during tooth preparation or caries removal.⁶

However, in his study, Parinyaprom et al.⁷ reported a high success rate of DPC (94.5%) despite including teeth presenting carious exposure, irreversible pulpitis, or even early periapical involvement. Furthermore, Asgary et al.,⁸ who practiced DPC in teeth with widened periodontal ligament space, and even periapical radiolucency, reported a 96.42% success rate. In fact, they showed that a periapical lesion may be associated with vital pulp teeth and can be the release of neuropeptides from afferent tooth fibers.⁷

On the other hand, the success rate of pulp capping in carious-exposed permanent teeth was the subject of a long debate.⁹ Many studies found that there is no difference in DPC outcomes between teeth with carious and non-carious pulp exposure.^{10,11} In Bogen et al.¹² study, it was of 97.96% over an observation period of 9 years.

The time of bleeding control was used as indicator of an irreversibly damaged pulp.⁷ For example, a severe pulp inflammation can be suggested with the occurrence of uncontrolled bleeding, and in this case, DPC cannot be indicated.¹³ It should be mentioned in this context, that during DPC, a rigorous bleeding control and cavity disinfection are decisive steps that can affect pulp tissue regeneration. In fact, a hemostatic solution should be applied with a sterile cotton at the exposure site for 5 min. Compared with chlorhexidine and sodium hypochlorite, saline is traditionally the most widely used and accepted hemostatic solution.¹⁴ The inhibition of odontoblasts differentiation can be due to the use of sodium hypochlorite. Calcium calcium silicate cement

setting time can be modified by the application of chlorhexidine in the exposure site.¹⁵ It is currently accepted to indicate partial or even full pulpotomy if hemostasis cannot be controlled after 5 min.⁶

On the other hand, the size of pulp exposure appropriate for DPC is still a source of controversy. Usually, most authors contraindicate DPC in teeth with exposures over than 1–1.5 mm in diameter. But this past evidence was contradicted by the Bogen et al. study showing a high success rate for long control period when performing DPC in teeth with exposures up to 2.5 mm.¹²

In the literature, many researchers have studied which capping biomaterial preserves best the integrity of exposed pulp. Initially, DPC with composite resins was suggested and their use did not report permanent aggressivity in healthy pulps.^{16,17} Then, their use in DPC became a source of controversy and even contraindicated by some authors reporting the poor quality of the newly formed dentin bridge.^{18,19}

Then, calcium hydroxide cements have been the material of choice for many decades. But their poor adhesion to dentin and the tunnel defects observed in the dentin bridges are their main drawbacks.

In the late 1990s, mineral trioxide aggregate (MTA) has been proposed for DPC,²⁰ due to its bioactivity, biocompatibility, antibacterial action, and its good stability and sealing ability.²¹ However, many clinical limitations of this material have been identified like crown discoloration, long setting time of 3 h, and poor handling properties.

In 2009, a new product was launched claiming to be a revolutionary material allowing to overcome some of these disadvantages. Biodentine™ (Septodont, Saint Maure des Fosses, France) is a tricalcium silicate-based cement, reported to preserve pulp vitality, promote pulp healing, and provide a bioactive substitute for natural dentin.⁴ According to the manufactures' data, the initial setting time is about 12 min. However, Kaup et al.²² evaluated its final setting time to be about 85 min.¹⁵

Concerning the problem of discoloration, some temporary coronal restorations with Biodentine™ seemed to be yellow after 2–3 months, like the case of our patient. This discoloration may be the consequence of their porosity leading to the absorption of dyes from oral cavity.¹⁵ However, gray discoloration of tooth crown after DPC was frequently observed with MTA-treated teeth. In fact, this discoloration can be caused by black precipitations resulted from interaction of bismuth oxide contained in MTA with dentinal collagen. Some authors explained this discoloration by oxidation of bismuth oxide, its oxygen became unstable, reacted with carbon dioxide in the air, and produced bismuth carbonate, which caused discoloration.⁷ Even for White MTA, a possible mechanism of tooth discoloration may be observed due to the calcium aluminoferrite phase of the powder.²³

Moreover, discoloration in teeth treated with MTA was shown to be potentiated by NaOCl application which is without effect in teeth treated with Biodentine™.⁷

Concerning the newly formed dentinal bridge, the observation of the interfacial layer between biomaterial and dentin showed no difference between Biodentine™ and MTA²⁴ with ion exchanges between the biomaterial and dentinal tissues explaining the adhesive properties of these cements.²⁵ More than that, it has been strongly proven that the capacity of hydraulic cements to induce a high quality of hard tissues makes them more efficient than calcium hydroxide.²⁶ In fact, MTA and Biodentine™ showed well homogeneous regularly dense reparative structures in continuity with the primary dentin.²⁷

According to Tran et al.'s²¹ study, the microscopic observation of this dentinal bridge showed big resemblance with the primary dentin. In fact, dentinal tubular structures were identified through this newly generated tissue. However, the density of tubules is lower than in the primary dentin.

Concerning its application, no cavity conditioning and no photo activation are required for Biodentine™. This can offer a great advantage in that it can be applied in bulk without affecting the quality of the marginal seal.²⁵

In the other hand, Biodentine™ was reported to exhibit good marginal integrity with no statistical difference in microleakage at the dentine-material interface when compared with resin-modified glass ionomer.²⁸

An *in vivo* investigation by Koubi et al.²⁹ showed that Biodentine™ used as a dentine substitute was performing well in conjunction with composite filling material. Due to its lower abrasion resistance, Biodentine™ must be covered by composite resin in definitive restorations. And thanks to its sealing ability, mechanical properties and its short clinical setting time, Biodentine™ could be indicated both as a temporary coronal restoration and a definitive dentin substitute.

The success of VPT may depend on several factors, one of the most important is the statue of the pulp tissue (the degree of pulpal bleeding may be a better indicator of pulpal inflammatory status), presence of an adequate blood supply, control of hemorrhage, presence of a healthy periodontium, a appropriate coronal seal.¹

Matsuo et al. suggested that a follow-up time of approximately 2 years is reasonable to reach a conclusion concerning the treatment outcome of a DPC.³⁰ Currently, there is no general recommendations regarding the minimum follow-up period for DPC using MTA or Biodentine™. This topic requires further investigation.⁸

Conclusion

Nowadays, DPC therapies can be indicated in many clinical situations like teeth with deep carious, or exposures up to 2.5 mm. Compared with the gold standard MTA cements, Biodentine™ showed a noninferior success rate when used as a pulp capping material resulting in a reparative dentin resembling on certain points primary dentin. Furthermore, it can be indicated for DPC in esthetic zones, and it could be an alternative to DPC with lower costs and shorter setting time.

Declaration of conflicting interests

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Ethical approval

Our institution does not require ethical approval for reporting individual cases or case series.

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Informed consent

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