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Case Report

Direct Pulp Capping with Bioactive Material: Biodentine

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Abstract

Biodentine is a calcium silicate based product, with mechanical properties similar to dentine tissue, stimulating formation of tertiary dentin and an effect on vital pulp cells.

In direct contact with pulp tissue it generates the formation of reparative dentin. Because of its lower cytotoxicity and the higher bio-inductive ability, biodentine may be considered as an ideal material for dentin-pulp complex regeneration.

This indicated its use for direct pulp capping after iatrogenic pulp exposure in a 45-year-old female patient at tooth 36.

With 24 months follow up, the tooth was clinically normal and tested positive for sensitivity with negative percussion tests. The radiography hasn't showed any pathological findings in the periapical area.

Choosing the right capping material is important, but other factors play a critical role in the success of direct pulp capping. However, the patient's age and the size of the pulp exposure, appear to play a secondary role in this case report.

Keywords: *Biodentine; Direct Pulp Capping; Pulp Vitality; Reparative Dentin*

Introduction

Conserving the pulp vitality must be the main concern of any clinician, the immune functions are preserved, structural and biological modifications that weaken the dental organ are prevented, but mainly the regeneration potential of pulp-dentinal complex is preserved.

The success of this therapy depends mainly on the capacity of the material used to initiate the pulp tissue repair and dentinal bridge formation.

Calcium hydroxide $Ca(OH)_2$ has long been considered a "Gold Standard" pulp capping therapy. Placed in contact with vital pulp tissue, it stimulates the formation of tertiary dentin, which seals exposures pulp by newly formed hard tissue. Nevertheless, calcium hydroxide has some drawbacks. Poor bonding to dentin, resorption and mechanical instability are among them. As a result, calcium hydroxide does not prevent microleakage in the long run. Moreover, the newly formed dentin bridges may contain defects and could act as a portal of entry for microorganisms [1,2].

Studies have shown that mineral trioxide aggregate (MTA) may be used as an alternative to $Ca(OH)_2$. It stimulates faster dentin bridges formation than calcium hydroxide, leading to pulp healing, and high success rates in clinical procedures. MTA is a bioactive, biocompatible,

antibacterial material with unique stability and high sealing ability. However, MTA has some drawbacks because of its long setting time making it hard to use, poor handling properties, high material costs, and potential discoloration of dental tissue [2-4].

New calcium silicate-based materials have been developed to improve some of MTA drawbacks. Biodentine™ (Septodont) is among these materials that has captivate attention in the last recent years and has been advocated to be used as a dentine restorative material in addition to endodontic indications similar to those of MTA [1].

Biodentine™ is a new calcium silicate-based restorative cement with properties dentin-like mechanical properties. It has a positive effect on vital pulp cells and stimulates tertiary dentin formation [2-5]. In direct contact with vital pulp tissue, it also promotes growth, proliferation and differentiation of stem cells regenerating and consequently the formation of reparative dentin [2-7].

It can be used on crowns and roots; Its crown applications include pulp protection, temporary closure, deep caries management, cervical filling, direct and indirect pulp capping and pulpotomy [8].

The following case report illustrates the use of biodentine in direct pulp capping.

Case Report

A female patient, 45 years old, consults for a defective amalgam on tooth 36.

The radiographic examination reveals a secondary decay under the restoration with no signs of periapical pathology but with an evident bone loss related to periodontitis (Figure 1).

Figure1: *Tooth 35 and 36 of a patient aged 45 years. Note the mesial secondary carious lesion on tooth 36 under the defective amalgame restoration.*

There was no history of pain and the tooth was tested positive on CO_2 snow sensitivity with no lingering pain and negative on percussion.

After informing the patient with the procedure, an anesthetic was performed and a rubber dam was put in place. Following cavity preparation, the carious dentin was completely excavated and the tooth cleaned. In the process the pulp cavity was exposed iatrogenically in one site > 1 mm (Figure 2).

Figure 2: *Iatrogenic pulp exposure occurred during caries excavation.*

Clinically the pulp tissue was vital. The consecutive bleeding in pulp exposure has been easily and quickly controlled. So, maintaining the pulp vitality by direct capping was decided. It wasn't the first indication but we wanted to push the limit of the use of biodentine since there was no pathological pulp signs and the patient was highly motivated.

NaOCl (2.5%) was applied for hemostasis, clearing and disinfecting the cavity. Biodentine was prepared as recommended by the manufacturer and applied to the exposed pulp tissue for direct capping and as a temporary restoration (Figure 3).

Figure 3: *Iatrogenic pulp exposure occurred during complete caries excavation.*

The entire cavity was filled with the material and occlusion was checked (Figure 4).

Figure 4: *After 12 to 15 minutes, the occlusion was checked.*

Subsequent polishing of the biodentine filling should be omitted.

At the follow-up visit, 7 days after direct capping the patient reported some increased cold and warm sensitivity of the tooth, but no other subjective symptoms. The pulp tests were all positive.

At 1 month follow-up, the symptoms originally reported had completely disappeared. Biodentine has been used as a bulk filling material and kept as a dentine substitute (Figure 5).

Figure 5: *Three months after direct capping, Biodentine was partially removed to place a permanent composite restoration.*

Three months after the procedure, Tooth 36 was clinically normal and tested positive for sensitivity and negative for percussion. A rubber dam was placed, the biodentine filling was reduced and kept as a dentin substitute, a matrix band was placed, and a composite material were applied for a permanent restoration (Figure 6).

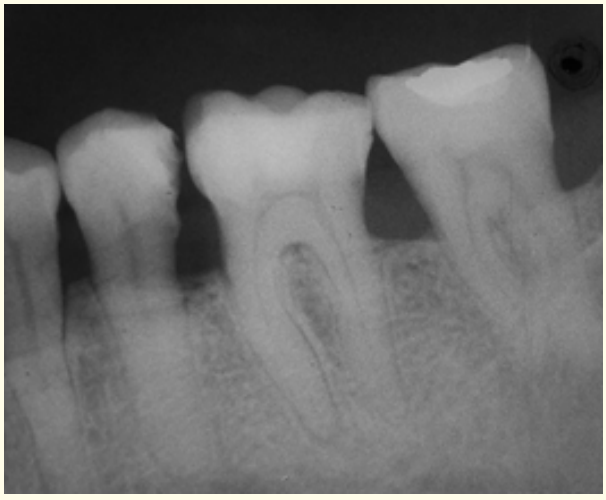

Figure 6: *The dental film recorded 3 months after direct capping does not show any apical pathological findings of tooth 36.*

Follow up was made at 6 months, one year and 2 years after direct capping, tooth 36 was clinically normal and again tested positive for sensitivity and negative for percussion. The recall radiography showed no evidence of periapical pathology showing good response to initial treatment with biodentine leting us believe in a pulp healing (Figure 7,8).

Figure 7: *1-year follow-up x-ray.*

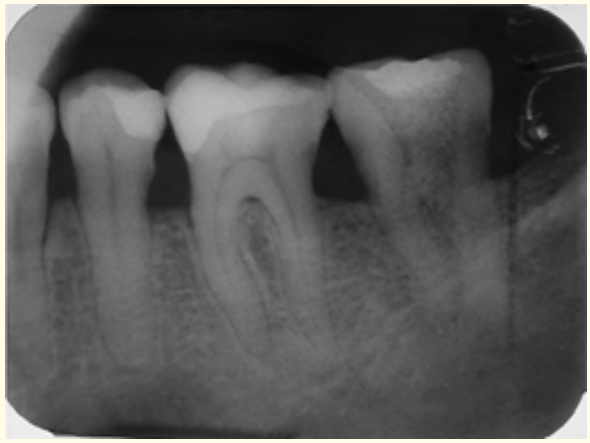

Figure 8: *2-years follow-up x-ray.*

Discussion

The ultimate aim of pulp capping therapy is to maintain all the functions of the pulp complex especially the regenerative potential.

The pulp is most often exposed during the removal of carious lesion. However, the indication of pulp capping after a carious exposure is controversial; the success rate is low due to the presence of inflammation. Many studies have shown that it is up to 30% [9-11].

On the other side, the success rate will increase significantly when it comes to mechanical exposure. In the absence of dental decay, the pulp is aseptic and the exposure is frequently minimal. This explains the very good prognosis after the treatment with pulp capping when this one is performed under a rubber dam [9,10].

Choosing the right capping material is primordial, but other factors play a critical role in the success of direct pulp capping: the tooth must be asymptomatic (Cat I-Baume), the consecutive bleeding in pulp exposure must be controlled easily and quickly, microbial contamination of the pulp should be avoided during treatment. However, the patient's age and the size or the site of the pulp exposure, appear to play a secondary role [11].

Indeed, our clinical case showed that despite the age of our patient, the size of the pulp exposure; that was important, the chances of saving the pulp were very low. However, we still tried pulp capping therapy with the absence of irreversible pulp inflammation signs and especially the motivation of the patient who was ready to return for regular monitoring sessions. We estimated the direct pulp capping was an excellent alternative to endodontic treatment. We choose the biodentine as capping material because of its high qualities.

Used for pulp capping, the material offers many advantages compared to other materials such as calcium hydroxide and Mineral Trioxide Aggregate, biodentine presented an excellent mecanical properties:

Compressive Strength

Biodentine has a specific feature which is its capacity to continue improving in terms of compressive strength with time until reaching a similar range with natural dentine. In the study by Grech., *et al*. [12], biodentine showed the highest compressive strength compared to the other tested materials [12,13].

Furthermore, in a study by Koubi., *et al*. biodentine was used as a posterior restoration and revealed favorable surface properties such as good marginal adaptation up to 6 months [14,15].

Microhardness

Grech., *et al*. showed that biodentine displayed superior values compared to bioaggregate and IRM [12-14].

Density and porosity

Biodentine and IRM exhibited the lowest degree of porosity. The low porosity of biodentine explains its superior mechanical properties [16,17]. The mechanical strength of the calcium silicate material is inversely proportional to its porosity.

Adhesion

Excellent adhesion properties, by mechanical anchoring in the microtubules without preparation. Infiltration of the initial material in the canalicules, followed by the formation of hydrated calcium silicate crystals which increases cohesion with time [16].

In summary, biodentine present excellent sealing properties, which can prevent microleakage and pulpal inflammation.

Biocompatibility of Biodentine

Biodentine presented an excellent biocompatibility with the pulp and the periodontal tissues. The cement biodentine placed directly on human pulp fibroblast does not cause cell death, as the MTA. Early studies [18] on this product have not demonstrated cytotoxicity, and that whatever the curing time. Moreover, this material does not affect the phenotypic expression of pulp fibroblasts. It does not affect the specific functions of target cells and can be safely applied directly to the pulp tissue [18].

Bioactivity

In Tran., *et al*. study [7], biodentine was compared to MTA and calcium hydroxide in terms of reparative dentin bridge formation, they noted that the structure induced by $Ca(OH)_2$ contained several tunnel defects as previously reported by Cox., *et al*. in 1996 [19]. These defective zones areas ease the migration of the microorganisms and predispose to an endodontic infection [19,20]. However, the quality of the newly formed dentin was also much more favorable with biodentine compared to calcium hydroxide [1,14].

The three major disadvantages of Calcium hydroxide are; Material resorption, mechanical instability and the resultant failure of preventing microleakages are therefore avoided.

Shayegan., *et al*. [21] showed that biodentine has bioactive properties, encouraging hard tissue regeneration with no signs of moderate or severe pulp inflammation response. They further noted that the material had the ability to maintain a good marginal integrity due to the formation of hydroxyapatite crystals at the surface, which enhances the sealing ability. Due to its superior sealing potential, decreasing the risk of microleakage, which may cause the pulp infection or necrose and jeopardize the success of vital treatment procedures [14].

Laurent., *et al*. [5] showed that, upon application on the exposed pulp, biodentine had the potential to significantly increase TGFB-1 secretion from pulp cells. TGFB-1 induces differentiation of progenitor cells into odontoblast-like. These cells secrete restorative type of dentin matrix. Biodentine had the potential to significantly stimulating angiogenesis and the formation of mineralized areas [5-7].

In addition to the aforementioned favorable biological results, 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.

Furthermore, in a study by Koubi., *et al*. [15], biodentine was used as a posterior restoration and revealed favorable surface properties such as good marginal adaptation up to 6 months. 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 [15,22].

Direct pulp capping is used not only for accidental exposures of healthy pulps but also for pulps challenged by caries.

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 [23].

The pulp tissue should be clear from 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 quickly controllable.

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

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 close to the pulp. Preventing microorganisms from entering the pulp is a key factor for successful direct capping.

In more than 50% of problem cases, direct capping fails within the first two years. Teeth still vital two years after direct capping stand a good chance of retaining their vitality. More long-term clinical studies are, therefore, needed for a definitive evaluation of biodentine [8].

Conclusion

Biodentine is an interesting and promising product, which has the potential to make a major contribution to maintain pulp vitality among carefully selected patients for direct capping. Biodentine holds promise for clinical dental procedures as a biocompatible and easily handled product with short setting time.

The approach of the pulp capping in single visit simplifies and improves the clinical use of biodentine.

Conflict of Interests

The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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