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Biodentine: Current Development

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Abstract

The apparition of Biodentine represents an important advancement in the bio-conservative therapies, making them safer and less expensive. This is a tricalcium silicate cement from the "Active Biocilicate technology". It allows parallel to the induction of hard tissue, quality comparable to the MTA, to overcome the disadvantages of the latter through its physicochemical properties. Indeed, this mechanical strength similar to that of dentine, its excellent sealing and the absence of dyschromia in the anterior teeth have expanded its indications. So if, it can be used in restorative dentistry as a dentin substitute, a temporary filling, in pulp capping, or in endodontics in cases of resorptions and root perforations, in endodontic surgery, in apexification and revascularization techniques.

The aim of this subject is to provide an update of this product by illustrating its large applications by clinical cases.

Keywords: Biodentin, dentin substitut, direct capping, tricalcium silicates, dentin bridge, MTA, cells induction, endodontic surgery.

Introduction

Nowdays, bio-conservative therapy allows to repair the missing dental structures by using many fields of research, specially the filling biomaterials used. These ones behave as a physical support of the organization, growth and differentiation of cells through biochemical signaling. Hence the interest of developing bioactive materials that are able to interact with biological environments such as pulp and periodontium. It is in this context that tricalcium silicate cements such as MTA (mineral trioxide aggregate) have been developed. This biomaterial was initially designed for

retrograde cavities obturation in endodontic surgery and repairing roots perforations. Gradually, this filling materiel was use in other clinical situations : pulp capping, apexification, root resorption…(1,2). This material has demonstrated its effectiveness and has supplanted the use of calcium hydroxide which has been dismissed because of its disadvantages such as low adhesion to dentin, its resorption after placement, weakening the root dentin, porosity and tunnel imperfections of neoformed hard tissue (3,4). However, this new class of material has low mechanical properties, leads to cervical dyschromia in the long term and is difficult to handle (5,6). to counter this disadvantages, Septodont laboratory have developed a new material to micronize Portland cements, called “Active Biosilicate Technology”. They produced a formulation that combines the chemistry of calcium silicates with the requirements of restorative and endodontic dentistry techniques: Biodentine.

Biodentine : Definition and Presentation

Biodentine is a new bioactive cement, indicated as a dentin substitute both at the crown and the root. It stimulates living cells and induces the formation of hard tissue. In addition, it has a mechanical behavior similar to natural dentine, hence the name of Bio "dentine". It is in the form of a powder in a capsule and a liquid in a pipette (Fig.1). The powder contains mainly tricalcium and dicalcium silicate, calcium carbonate which plays the role of the charges and zirconium dioxide which is responsible of the material radio-opacity. The liquid is composed of calcium chloride in aqueous solution with a mixture of modified polycarboxylate. Calcium chloride will act as a setting accelerator. This does not exceed 12 minutes after mixing the powder with the liquid (7,8).

Physical and mechanical properties

In the Septodont laboratories, the physicochemical behavior of Biodentine® was compared with that of glass ionomer cements and ProRoot® MTA by a series of tests. It appears that, overall, Biodentine® has a mechanical behavior similar to CVI, superior to ProRoot® MTA, and similar to natural dentin (9). Indeed, Biodentine® is an evolutionary material that improves its mechanical properties over time. The electrochemical impedance method shows that even after the initial setting, Biodentine® cement continues to improve its internal structure by decreasing its porosity. This is explained by the fact that the C3S hydration reaction continues in time with a progressive increase in the strength of the material (7). Thus, the compressive strength increases very rapidly at the end of setting to reach an average value of 240 MPa after 24 hours (9) and 300 MPa after 1 month. Similarly, for its hardness, the Vickers microhardness tests show a continuous increase in values up to 7 days with a relative stabilization at one month around 90 HVN. These recorded values are of the same order as those of natural dentin (Colon et al., 2010b).

Moreover, the precipitation of calcium silicate crystals in the dentinal tubules, whose cohesion increases with time, creates a micro-anchorage and promotes adhesion of the material to the dentin (9).

Its erosion in acid solutions is limited and inferior to that of ionomer glasses. (7). Therefore, it is possible for this product to come into contact with saliva. In a study in which Biodentine ™ was compared with the Z100 composite (3M) via a sandwich-open restoration. It has been shown that the reduction of marginal adaptation only appears after six months of placement of the material (8,9). This property clearly distinguishes

Biodentine ™ from MTA products and allows it to be considered as a temporary restoration material (10,11).

Another difference is represented by the fact that the bismuth oxide is replaced in the Biodentine ™ by zirconium oxide. It is well known that bismuth oxide is one of the main causes of dental dyschromia with MTA products in both gray and white forms. Thus, the use of Biodentine is especially preferred for the anterior sectors.

Biological properties

According to Schröder, the first action of a bioactive material is to induce the formation of hard tissue by the cells of body fluids (13). Many studies have shown that Biodentine® has excellent biocompatibility with pulp and periodontal tissues. It induces the proliferation and activation of periodontal fibroblasts, pulpal cells, cementoblasts, osteoblasts and mesenchymal cells (14). Indeed, when they are incubated in the presence of extracts of Biodentine, the pulp fibroblasts secrete a matrix that is progressively mineralized following the expression of differentiation markers such as collagen type I, osteonectin, dentinal sialoprotein and the nestin (15). Histologically, this secretion is fast and stops later, thus ensuring the preservation of the pulpal vitality (7). This action is explained by the fact that this material has the same effects as calcium hydroxide and thus releases the calcium and hydroxyl ions.

According to Dr. About (2009), MTA and Biodentine both have impacts on the gene expression of cells that are not quite the same and that probably change with the duration of contact (9). According to Formosa et al., The main properties of the two cements are substantially the same, although the results show that Biodentine has better in vitro bioactive properties. These are measured by the amount of calcium hydroxide produced and the formation of calcium phosphates when the materials are placed in simulated organic media (16). Zeid et al. confirm that Biodentine® releases more calcium ions than MTA (17). This release decreases with time.

Thus, the improved properties of Biodentine have widened its indications by covering the following situations:

1. Cavity floor and dentin substitute for final restorations.
2. Direct pulpal capping following a carious lesion or trauma.
3. Repair external and internal perforations and resorptions.
4. Pulpotomy on temporary teeth.
5. Apexification.
6. Revascularization technique of immature permanent necrotic teeth.
7. Retro-filling in endodontic surgery.

Biodentine Protocol and practice advice

The material should be prepared according to the fabricant recommendations. These stipulate that it is necessary (9):

1.First, remove the powder by manually shaking the capsule for 10 seconds. It is not advisable to hit it with a hard surface so as not to compress the powder against the wall and not to sufficiently integrate it into the mixing process.

2. Open the capsule and place it on the white support. It is advisable to open it, hit against the cap to eliminate air bubbles present, so as not to hinder the homogeneous flow of liquid.

3. Open the bottle of liquid by rotating the sealed cap.

4. Pour 5 drops of the liquid into the powder. The drops are formed by exerting a light and continuous pressure on the bottle.

5. Close the capsule and place it on a vibrator with a speed of the order of 4000 to 4200 oscillations / min. It is best to shake the capsule back and forth several times to moisten the cement particles.

6. Mix together for 28 to 30 seconds. The final mix should have the consistency of a bright and perfectly condensable mastic.

7. Open the capsule and check the consistency of the material. If a thicker consistency is desired, wait 30 seconds to one minute before retesting without exceeding the working time.

8. Recover the Biodentine material using the spatula delivered in the box.

It should be noted that depending on the desired use, it is possible to handle the Biodentine using an amalgam holder, spatula or an endodontic macerator. The material is placed in the cavity avoiding the inclusion of air bubbles. Finally, care must be taken to ensure that it fits the walls of the cavity and the edges of the restoration without compressing the material. In addition, the first recommendations of the fabricant stipulate to wait for another session before performing the final restoration of the cavity. However, later studies suggest that one-session treatment would be possible (11,12). When opting for this procedure, it is important to wait until the material is set before proceeding to the final restoration. The Biodentine® surface should have a matt appearance. During this setting time, the cement must not be milled and must remain dry. Hence the preference to use self-etching dentin adhesives to avoid rinsing with water prior to the etching step.

Conclusion

Since its emergence, Biodentine has demonstrated its clinical effectiveness. Its physico-chemical and biological properties allowing to expand its indications and to easily consider different treatments. The various publications with the strength of proof confirm that it can be considered as an alternative to MTA. However, it is necessary to wait for a number of comparative studies more important and a significant clinical decline to judge before proclaiming the Biodentine as a reference material.

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