IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 18, Issue 12 Ser.5 (December. 2019), PP 68-72
www.iosrjournals.org

Biodentine: A Contemporary Dentin Deputy and Boon to the Field of Dentistry

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Abstract
When compared to conventional restorative materials like Amalgam,GIC, Composite and MTA in market the new bioactive n biocompatible material known as Biodentine has been showing phenomenal clinical applications as a permanent bulk dentin deputy in restorative dentistry. Due to its good handling properties, short working time, mechanical properties and its interactions with both hard and soft tissues lead to a marginal sealing preventing marginal leakage biodentine has been overcome the drawbacks of other materials.MTA inspite of having many advantages its constraints cannot be overlooked. In a crispe it is able to act as a reliable alternative to dentin in both coronal and radicular portions of tooth

Date of Submission: 02-12-2019 Date of Acceptance: 18-12-2019

I. Introduction

One of the major losses which hamper the integrity of the tooth structure to a significant extent is loss of dentin .Irrespective of whether it is in coronal portion or the radicular one, the dentin loss must be substituted with an artificial material, which can restore the physiological integrity of the tooth structure.{1}

Because the core of conservative dentistry and endodontics revolves around the preservation and treatment of the pulp dentine complex. Dentine plays an important role in preserving the vitality of the tooth.(2}

Calcium hydroxide was the most preferred material for preserving the pulp vitality but due to its drawbacks like mild antibacterial properties, poor cohesive strength, greater solubility, and marginal leakage.(3) In spite of a highly alkaline pH of this material, a dentin bridge can form within 3 months providing a protection to the underlying pulp with mild or moderate inflammation. However, several studies demonstrated a partial dissolution and that this bridge has tunnel defects.(4 -5}.

MTA was introduced in 1990. MTA was considered as a "GOLD STANDARD" material for defects related to dentin due to its excellent properties.(6}However, some shortcomings have been reported with this material like cost factor ,long setting time of 2 h 45 min, weak mechanical properties and difficult handling properties,tooth discoloration has been reported when used for revascularization(7,8)

Although various calcium silicate based products like MTA have been launched to the market their drawbacks led to the pathway for the creation of a new calcium silicate based biomaterial called as 'BIODENTINE', introduced by Septodont's research group (9). Like ProRoot MTA and Portland's cement , it is a calcium-based cement. Compared to others calcium based cements, this material presents two advantages: i) a faster setting time of about 12 minutes and ii) higher mechanical properties.due to its high mechanical properties with excellent biocompatibility as well as bioactive behavior it was rightly called as 'Bioactive Dentine Substitute'or 'Dentine In Capsule(10 ,11)

Biodentine Availability

it is available as 2 bottle system containing powder in capsules and liquid in pippetts .it just a modification of MTA to overcome its drawbacks.(11)

Chemical composition

Powder	Liquid
Tricalcium silicate – main core material	Calcium chloride - accelerator
Dicalcium silicate – second core material	Hydro soluble polymer - water reducing agent
Calcium carbonate and oxide– filler	
Iron oxide – coloring agent	
Zirconium oxide – radioopacifier	

(Courtesy: Biodentine Scientific File , Septodont 2010)

Table 1: Chemical composition of Biodentine

PROPERTIES OF BIODENTINE

Setting reaction

it is hydration reaction . The reaction of the powder with the liquid leads to the setting and hardening of the cement. The hydration of the tricalcium silicate leads to the formation of a hydrated calcium silicate gel (CSH gel) and calcium hydroxide. (12)

Therefore, final products of this process are hydrated calcium silicate gel [CSH gel] [CSH= 3CaO.2SiO2.3H2O] and calcium hydroxide [Ca(OH)2]. (13)

2 [3 CaO.SiO2] + 6H2O 3CaO.SiO2.3H2O + 3 Ca(OH)2

Setting time

The working time of Biodentine is up to 6 minutes with a final set at around 10-12 minutes. This represents a great improvement compared to the other calcium silicate dental materials (ProRoot MTA), which set in more than 2 hours and 45 minutes.

Manipulation

Working time- Upto 6 minutes.5

Final setting time – 10 to12 minutes.5

Biodentine can be manipulated by two methods namely the mechanical and the manual method. In mechanical method, both powder and liquid are added and mixed together for 30 seconds in a triturator. In manual method, a mixing pad is taken and both liquid and powder are blend well with spatula for about 30 -45 seconds (9)

Compressive strength

capacity to withstand masticatory forces mainly depends on the compressive strength of the material. MTA cannot be used in areas like furcations because of its low compressive strength (40 MPA at 24 hr and 67.3 MPA at 21 days).{**3**}Biodentine shows compressive strength equal to that of natural dentine.

In the study by Grech et al Biodentine showed the highest compressive strength compared to the other tested materials due to its low water: powder ratio. **(14)**

According to a study conducted by Naziya et al Biodentine exhibited a compressive strength of 170 MPa at 24 hr and increased substantially to 304 MPa after the material was placed in moisture for 28 days. This value is close to the compressive strength of human dentine (297 ± 24 MPa).13 The 24 hr push out bond strength of biodentine is significantly higher than MTA, making it better in repairing furcal perforations

Biocompatability

Biocompatibility of a material is an important property when it is used as a pulp capping, perforation repair or as a retrograde filling agent**.**

Laurent et al.(**15**)revealed that Biodentine is non-toxic and hasno adverse effects on cell differentation and specific cell function. They reported that Biodentine increases TGF-B1 (growth factor) secretion from pulp cells which causes angiogenesis, recruitment of progenitor cells, cell **differentiation** and mineralization. The material is inorganic and non-metallic and can be used in direct and indirect pulp capping procedures as a single application dentin substitute without any cavity conditioning treatment.

Bioavailability

About et al. [**16}** in 2005 investigated that Biodentine material is non-cytotoxic and nongenotoxic for pulp fibroblast at any concentration and stimulates dentin regeneration by inducing odontoblasts differentiation from pulp progenitor cells and promote mineralization, generating a reactionary dentine as well as a dense dentine bridge.so biodentine does not seems to affect the target cells specific function irrespective of its application in direct or indirect method.

Antibacterial activity

Calcium hydroxide ions released from cement during setting phase of Biodentine increases pH to 12.5 which inhibits the growth of microorganisms and can disinfect the dentin. So biodentine exhibits significant amount of antibacterial activity.

Porosity and density

Lower the porosity, higher is the mechanical strength.
Biodentine exhibited lower porosity compared to ProRootMTA, thereby had higher mechanical strength.(**13**)

Push out bond strength

Since biodentine is used as a dentin substitute and perforation repair material, it should have sufficient amount of push-out bond strength with dentinal walls for the prevention of dislodgement from operated site.. Biodentine showed a markedly higher push –out bond strength than MTA after 24 hours.(**17**)

Flexural strength

High flexural strength is a definite pre-requisite for any restorative material for its long term efficiency in oral cavity. This property is essential in order to estimate whether the material is capable of withstanding high stress or pressure. When compared to dentine which has a flexural strength of 20 Mpa, biodentine is known to have 34 Mpa which was estimated using three point bending test after 2 hours.(**13**)

Vickers hardness

Biodentin exhibits sufficient hardness to be used as dental material. After 2 hours, the hardness of biodentineTM is 51 VHN and reaches 69 VHN after 1 month. In an interesting study, Camilleri [**18**] evaluated microhardness of Biodentine, Fuji IX conventional GIC and resin modified GIC and found that Biodentine exhibited excellent surface hardness when etched.

Radiopacity

Biodentine contains zirconium oxide, allowing identification on radiographs. According to the ISO standard 6876, Biodentine displays a radiopacity equivalent to 3.5 mm of aluminum. This value is over the minimum requirement of the ISO standard (3 mm aluminum). This makes BiodentineTM particularly suitable in the endodontic indications of canal repair.

Adhesion

The mechanical adhesion of BiodentineTM cement to dental surfaces may result from a physical process of crystal growth within dentine tubules leading to a micromechanical anchor. The possible ion exchanges between the cement and dental tissues constitute an alternative hypothesis, or the two processes may well combine, eventually contributing to the adhesion of the cement, as it appears at the interface of BiodentineTM - adhesive systems.

Discoloration

A study conducted by Camilleri et al found that biodentine do not undergo discolouration when compared to Neo MTA plus, MTA Plus(**19,20**). It shows stability of colour and can be used as a substitute for composite restorations in highly esthetic areas as well.

Marginal Adaptation and Sealing Ability

Biodentine after placement enters the pores which is caused by dissolution of organic tissue in dentinal tubules thus establishing micro mechanical bond and providing excellent anti- bacterial seal.

Advantages of Biodentine

although biodentine has wide range of advantages the following 4 have more clinical significance.
1. Reduced setting time
2. Improved mechanical properties

3. Bioactivity of material
4. Better handling & manipulation

Applications of biodentine in dentistry

Dentine Substitute

It is used as a dentin substitute under a permanent restoration, and can be categorized as Indirect pulp capping material. No post-operative complications were established when biodentine was used as an alternative in class 1 and 2 composite restorations.
(**21**). It showed a very strong marginal adaptation and superior surface finish with absence of pain and sensitivity on usage of biodentine.(**18**)
A study by Valles Et al suggested that biodentine showed colour stability and results proved that biodentine could be a substitute for light cured restorative materials in esthetically sensitive areas.(**22**)

Pulp Capping

Biodentine is recommended as an effective medicament for pulp capping procedure (**11**)as it has the unique feature in dentine bridge formation and tissue reaction.(**11,23,24**) Moreover, it has the ability to begin early mineralization from pulpal cells by releasing TGF- BETA, thereby encouraging pulp healing.(**11**)

Pulpotomy

Villet et al. [**25**] performed partial pulpotomy in an immature premolar and detected fast tissue response (radiologically evident) by the dentin bridge formation and continuation of root development in shorter time. They experienced increased speed of pulpal response and homogenous bridge formation making Biodentine good choice than calcium hydroxide **[26-28]**

Use of Biodentine as an endodontic repair material

The endodontic indications of BiodentineTM are similar to the usual calcium silicate based materials, like the Portland cements and MTA. Biodentine has been recommended for perforation repair, formation of apical plug and furcation repair.

Retrograde Filling Material

The use of Biodentine as root end filling material has also been suggested. To evaluate, this application, Soundappan et al. [**29**]

compared MTA, IRM and Biodentine as retrograde filling material and found that at 1mm level there was no difference among tested materials but at 2mm level MTA was superior to both IRM and Biodentine. The results reveal that further research is required before Biodentine can be advocated as root end filling material.

II. Conclusion

Biodentine proves to be a most promising material of all due to its exceptional properties of being easy handling and fast setting time are the major advantages in comparison to other similar materials available commercially. It is important to know that Biodentine does not require any surface conditioning treatment. It can be cut and reshaped like natural dentin. Biodentine surface can be bonded like the natural dentin with different adhesives before final composite resins application. Thereby, overcome the shortcomings of other material like that of MTA, calcium hydroxide and formocresol which are available commercially. Thus, biodentine proves to be a **'GOLD STANDARD'** replacing all other materials for treatment of primary and permanent teeth. However further studies and evidences are required to extend the future scope of this material regarding various clinical applications.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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Dr Lukka Jagadish. "Biodentine: A Contemporary Dentin Deputy and Boon to the Field of Dentistry." IOSR Journal of Dental and Medical Sciences (IOSR-JDMS), vol. 18, no. 12, 2019, pp 68-72.