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Biodentine: Biologically Active Substitute for Dentin in Capsule – A Review

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ABSTRACT

Quest for newer material are never ending especially in the field of dental and oral health. In the era of biomaterialistic dentistry several newer materials have been formulated, and standardized to obtain maximum clinical benefits and improved performance. One such material introduced was Biodentine which had numerous clinical applications. This article aims to compile and review the availability, composition, manipulation, mechanism of action, properties and clinical implications of Biodentine.

KEYWORDS: - Biodentine, Dentin, manipulation, Biocompatibility

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INTRODUCTION

For decades calcium hydroxide was used for maintaining vitality of pulp because of its capability to induce tertiary dentin formation.[1] However; due to poor bonding capacity and material resorption its use was restricted.[2] MTA introduction in dentistry by Torabinajed (1990) was a boon that changed the face of dentistry. All the treatment which could be carried out with $Ca(OH)_2$ was replaced with MTA. MTA was considered the ideal material of choice for replacement of dentinal defects with good biocompatibility and marginal sealing ability.[3] Although this material had better biological properties; it possessed some drawbacks like discoloration potential, difficult handling properties, long setting time, and high material cost.[4] Many of these drawbacks have been improved with modifications but handling property is still a concern. Recently Septodont research group has come up with a new class of dental material which possessed high mechanical properties with excellent biocompatibility, as well as instituted bioactive behavior. They termed it as Biodentine. In addition to basic composition of already known calcium silicate based cements (Portland, MTA); Septodont increased the physio-chemical properties which made Biodentine clinically easy to handle and compatible. Biodentine has revolutionized the management of deep carious lesion whether or not the pulp is exposed. This article is aimed to review all the aspects of this material with emphasis on its properties and various clinical uses.

COMMERCIAL NAME:- biodentine *also* called as "dentin in a capsule" or bioactive dentine substitute.

Table No: - 1: Composition of biodentine cement[5]

POWDER	
Tri-calcium silicate(C_3S)	Main core material
Di-calcium silicate (C_2S)	Second core material
Calcium carbonate & oxide	Filler
Iron oxide	Shade
Zirconium oxide	Radio pacifier
LIQUID	
Calcium chloride	Accelerator
Hydrosoluble polymer	Water reducing agent

MODE OF SUPPLY: - Powder and liquid form

FORMULATION

Septodont introduced the proprietary formulation method by which Biodentine was made which used ceramic mineral chemistry for the production of bioactive material. But this material was different from the usual dental calcium silicate based cements as it did not contained calcium aluminates and calcium sulfate found in usual similar products.

MANIPULATION:-

Mechanical method: Powder and liquid in the capsule in triturator for 30 seconds

Manual method: - Powder and liquid are mixed over a mixing pad with spatula for 30-45 secs

SETTING REACTION:-

Calcium silicate present in the cement undergoes hydration reaction to produce hydrated calcium silicate gel (CSH gel) and calcium hydroxide ($Ca(OH)_2$).

$$2(3CaO.SiO_2) + 6H_2O \longrightarrow 3CaO.2SiO_2.3H_2O + 3Ca(OH)_2$$

C_3S CSH

The dissolution process of the hydration reaction takes place at the surface of each grain of calcium silicate. Due to saturation of the medium by hydrated calcium silicate gel and calcium hydroxide; particle precipitation starts occupying the surface of the particles and in the pores of the powder. As the reaction progress the unreacted tricalcium silicate grains are surrounded by layers of calcium silicate hydrated gel. This makes them relatively impermeable to water and thereby slowing down further reactions. Hardening process starts as soon as the crystals formed are deposited in a supersaturated solution.

MECHANISM OF ACTION

The action of biodetine is through the formation of calcium hydroxide which because of high pH causes irritation at the exposed area. This causes division and migration of precursor cells to substrate surface followed by addition and cyto-differentiation into odontoblast like cells. Thus Biodentine

induces mineralization process by expressing markers of odontoblasts & increases TGF-Beta1 secretion from pulpal cells leading to mineralization in the form of osteodentine after its application.[6,7]

PROPERTIES

Setting time

The setting time is short with an approximate time of 12 minutes, which facilitates its use in immediate crown restoration especially in the field of pediatric dentistry. This makes it available directly for intraoral function without fear of the material deterioration.[8]

Anti bacterial properties

Due to high alkalinity Biodentine shows inhibitory effect on the micro organisms thus leading to the disinfection of surrounding hard and soft tissues.

Biocompatibility

Lauren et al tested Biodentine to evaluate its genotoxicity, cytotoxicity and its effects on the target cells specific function. He concluded that biodentine preserves pulp vitality and promotes its healing process.[9]

Push out bond strength

Biodentine has significantly higher push-out bond strength as compared to MTA. Gunesar MB et al 2013 performed a study on Biodentine and found that it shows considerable performance as a perforation repair material even after being exposed to various endodontic irritants.[10]

Elastic modulus: - 22 Gpa, is very similar to that of dentine at 18.5.[11]

Compressive strength: - 220 MPa which is similar to dentine of 290 MPa.[11]

Microhardness**:** - 60 VHN is same as that of natural dentin.[11]

Flexural strength: - 34 MPa is more than dentine (20MPa).[11]

Acid resistance: - Biomaterial interfacial imaging showed an improved interface between the dentine substitute Biodentine and the adjacent phosphate-rich hard tooth substance. This means that surface disintegration leading to formation of crystals over the surface is reduced even after exposure to various acids.[11]

Marginal adaptation and sealing ability

The high pH of the bioactive cement causes organic tissue dissolution of the dentinal tubules, thus creating micropores similar to the achieved after acid etching of enamel for bonding of composites. The material after placement enters into these pores and forms microscopic cones thereby achieving the micromechanical bond. This enables to create a stable anchorage along with a, bacteria-tight seal.[11]

Radiopacity

Zirconium oxide provides the radiopacity in Biodentine as compared bismuth oxide used in other materials.

APPLICATIONS

Pulp capping

Biodentine can be used as both direct and indirect pulp capping agent because of its ability to induce mineralization through osteoblastic stimulation and pulpal release of growth factor to promote pulpal healing

Endodontic repair material

Due to its improved physio-mechanical properties it is considered over MTA for:-

1. Repair of root perforations:-
2. Apexification
3. Root end filling

Base under composite restoration[5]

Restoration of teeth with composite has certain specific demands like bonding to the base, no interference with polymerization etc. So far a clinical study performed by the Septodont group on 116 patients has reported an excellent biocompatibility and tolerance with Biodentine applied as a base with one year follow-up. This may open future gates for biodentine to used cavity lining and base under the permanent composite restoration.

CONCLUSION

Disadvantages of calcium hydroxide and MTA have given a way for the use of Biodentine with better results.

- Due to major advantages and appreciable properties and ability to achieve biomimetic mineralization, Biodentine has great potential to revolutionize the management of affected tooth in the operative dentistry and endodontics.
- However further studies are still needed to evaluate the clinical efficacy and extend the future scope of this material.

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