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Review Article

Biodentine- A Unique Dentine Substitute

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ABSTRACT:
Biodentine is a new bioactive cement with dentine like mechanical properties, which was developed by Septodont, France, which can be used as a dentine substitute on crown and roots, has positive effect on vital pulp cells and stimulates tertiary dentin formation. This review of literature aims to describe about composition, properties, advantages and clinical application of biodentine.

Keywords: Biodentine, Dentine substitute, MTA

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INTRODUCTION

Since 1920 calcium hydroxide has been standard material for maintaining the vitality of pulp since it is capable of stimulating tertiary dentin formation. However it has some drawbacks like poor bonding to dentin, material resorption. In present era of restorative dentistry and endodontics calcium silicate based materials have gained popularity in recent years because of their better biocompatibility and tissue repairing abilities. A wide range of materials are available of which MTA is known to be the best as an endodontic repair material as well as an ideal pulp capping agent. MTA was introduced by Torabinejad M in 1990 and it has been used for the past twenty five years due to its excellent biocompatibility and sealing ability. Despite its good physical and biological properties there are some disadvantages like prolonged setting time, difficult handling properties and its inherent tendency to undergo discolouration.[3,4] To overcome this problem researches led to the pathway for the creation of a new calcium silicate based biomaterial called as 'BIODENTINE', introduced by Septodont's research group, France. It exhibited the identical excellent biocompatibility like that of MTA which can be placed in direct contact with the pulpal tissue, high mechanical properties and good sealing ability with dentine. As it fulfilled all the physiognomies of an ideal restorative material such as having good physical and mechanical properties, technical features of the material from the perspective of the dental professional, acceptability of the material by the patients, and other clinical features that lead to the material's effectiveness, it was rightly called as 'Bioactive Dentine Substitute' 'Dentine In Capsule'. Soon after its unveiling, its applications are greatly utilized in the department of Pedodontics, Operative dentistry, Endodontics.[5,6]

COMPOSITION OF BIODENTINE[6,7,8]

Biodentine is available as a powder in a capsule and liquid in a pipette. (Table no.1)

Table no 1: Composition of Biodentine

Powder		Liquid	
Ingredient	**Function**	**Ingredient**	**Function**
Tri-calcium silicate	Main core material	Calcium chloride	It acts as an accelerator.
Di-calcium silicate	Second core material	Hydrosoluble polymer	It is a water reducing agent
Calcium carbonate & oxide	Act as a filler		
Iron oxide	Colouring agent		
Zirconium oxide	Radioopacifier		

MANIPULATION

Biodentine can be manipulated by two methods namely the mechanical and the manual method. In mechanical method, both powder (0.7 gm) and liquid (0.18 ml) 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]

WORKING TIME

Upto 6 minutes

FINAL SETTING TIME

10 to12 minutes

PROPERTIES OF BIODENTINE

SETTING REACTION

When liquid and powder is mixed together, chemical reaction begins where calcium silicate and water reacts thus resulting in hardening of the cement. Therefore, final products of this process are hydrated calcium silicate gel [CSH gel] [CSH= 3CaO.2SiO2.3H2O] and calcium hydroxide [Ca(OH)2].[10] The fast setting time of 9-12 minutes is achieved by decreasing the particle size, addition of calcium chloride accelerator to the liquid component and decreasing the liquid content.[11]

COMPRESSIVE STRENGTH

Compressive strength is considered as one of the main physical characteristics of hydraulic cements. It is essential that the cement has the capacity to withstand masticatory forces, in other words, sufficient compressive strength to resist external impacts.[12] Biodentine shows compressive strength equal to that of natural dentine. Grech et al. (2013) conducted a study which calculated the compressive strength of biodentine in Hank's balanced salt solution to be 67.18 Mpa when immersed which was relatively much more higher than MTA which has 40 Mpa.[11] 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).[14]

ANTI BACTERIAL PROPERTIES

The antibacterial properties are due to the release of calcium hydroxide (Ca(OH)2) on surface hydrolysis of the calcium silicate components. This high pH also exerts a clear inhibitory effect on microorganisms. Due to high alkaline pH Biodentine has inhibitory effect on the micro organisms. In addition, the alkaline change leads to the disinfection of surrounding hard and soft tissues.[15]

BOND STRENGTH

Biodentine has significantly higher push-out bond strength than MTA. The statistical ranking of push out bond strength values are Amalgam≥ IRM ≥ Biodentine > MTA.[16]

RADIOPACITY

Radiopacity is an important property expected from a retrograde or repair material as these materials are generally applied in low thicknesses and they need to be easily discerned from surrounding tissues. Zirconium oxide is used as a radio opacifier in Biodentine contrary to other materials where bismuth oxide is preferred as a radiopacifier. The mean radiopacity for MTA has been found to be 7.17 mm of equivalent thickness of aluminium and Biodentine reported a radiopacity to 3.5 mm of aluminium.[17,18] Grech L et al., evaluated the radiopacity of Biodentine, bioaggreagte and tricalcium silicate cement and found that all materials had radiopacity value greater than 3 mm of aluminium[11]. However Caron G et al., observed lower radiopacity of biodentine when compared to MTA Angelus.[19]

MARGINAL ADAPTATION AND SEALING ABILITY

The micromechanical adhesion of biodentine is caused by the alkaline effect during the setting reaction. This high pH causes organic tissues to dissolve out of the dentin tubule. The alkaline environment at the boundary area of contact between biodentine and hard tooth substance opens a path via which the dentin substitute mass can enter the exposed opening of the dentin canaliculi. This enables biodentine to be keyed to the dentine by means of innumerable microscopic cones, creating a stable anchorage with a sealing, bacteria-tight effect.[6,15]

BIOACTIVITY

In both direct and indirect application, Biodentine does not seem to affect the target cells specific functions. About et al. in 2005 investigated that Biodentine material is non cytotoxic and non genotoxic 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.[6]

Comparison of MTA and Biodentine (Table no 2)

Properties	MTA	Biodentine
Setting time (Minutes)	Initial-70 Final-175	Initial-6 Final-10-12
Compressive strength (MPa)	- 7.5(24hr)	131.5(1hr) 241.1(24hr)
Flexural strength (MPa)	14.27	34
Microhardness (KHN)	37.54-53.56	60
Ph	Initial 10.2,rises to 12.5 after 3 hours	12
Porosity	Due to low water content in the mixing stage Biodentine exhibits lower porosity than MTA	
Mechanical resistance	Lower	Higher
Radiopacity	7.17 mm of equivalent thickness of aluminium	3-5 mm of equivalent thickness of aluminium

Application of Biodentine (Table no 3)

Application of Biodentine	Observation
Pulp capping	Biodentine is recommended as an effective medicament for pulp capping procedure, as it has the unique feature in dentine bridge formation and tissue reaction.[6] Mahmoud et al. (2018) suggest that the Biodentine had a similar effect on dentin bridge formation similar to MTA.[20]
Pulpotomy	Favourable biological, physical, mechanical, and good manipulation properties of Biodentine show that this material can be used efficiently as a pulpotomy medicament in the clinical practice. Ahuja S et al. (2020) found 100% success rate over 9 month follow-up with biodentine pulpotomy.[21]
Apexification	Single visit apexification with a novel biocompatible material like Biodentine is a new boon in effective management of teeth with open apex. Nayak G et al. (2014) found positive clinical outcome in his case encouraging for the use of Biodentine in immature teeth with necrotic pulps and wide-open apices.[22]
Perforation Repair	Biodentine having a high push out bond strength even after being exposed to vast number of endodontic irrigants makes it obviously a preferred choice. Due to the presence of this excellent property in biodentine, it has become a preferred material of choice in perforation repair.[6] Guneser et al. (2013) biodentine showed considerable performance as a perforation repair material even after being exposed to various endodontic irrigants as compared to MTA.[23]
Retrograde Filling Material	Pawar AM et al. (2013) published a case report in which biodentine was used as a retrograde material for traumatized maxillary central and lateral incisors with large periapical lesion. It was identified that biodentine caused progression of periapical healing.

DISCUSSION

The clinical uses of bioceramics have increased exponentially over the years because of their wide range of applicability in restorative dentistry and endodontics. The introduction of MTA was considered as a major break-through in the history of material science and since then the properties of this material have been improvised in order to achieve its maximum benefits. However, there have been a few limitations of this material which have always compelled the researchers worldwide to look for its alternatives. Difficult manipulation, slow setting time and high cost are the ones to name a few. In order to overcome these limitations, a new bioceramic material named Biodentine was introduced in the year of 2010 which has proved to be a second major break-through.[25] Biodentine proves to be a most promising material of all due to its exceptional properties of being highly biocompatible, bioactive, shorter span of setting time, being versatile as well as easy of handling. 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, long term clinical studies and trials are required to draw further inferences regarding its scope for applications in various fields of dentistry.[26]

CONCLUSION

Biodentine was developed as a new class of dental material which could conciliate high mechanical properties with excellent biocompatibility, as well as a bioactive behaviour. Biodentine fulfils the requirements found in the literature for a material suitable for biocompatibility, long-term impermeability, antibacterial properties, and induction of hard tissue regeneration, stability, low solubility, non-absorbability and ease of handling. Due to major advantages and appreciable properties and ability to achieve biomimetic mineralisation, Biodentine has great potential to revolutionise the management of affected tooth in the operative dentistry and endodontics.

REFERENCES

1. Duda S, Dammaschike T. MaBnahmenzurVitalerhaltung der pulpa. GibtesAlternativenzumkalziumhydroxidbei der direktenuberkappung? Quintessenz;59,2008,1327-1334, 1354.
2. Torabinejad M, Parirokh M. Mineral trioxide aggregate: A comprehensive literature review – Part II: Leakage and biocompatibility investigations. J Endod 2010;36:190-202.
3. Tay et al. 2007, Reyes-Carmona et al. 2009, Torabinejad & parirokh 2010.
4. Parirokh M, Torabinejad M. Mineral trioxide aggregate: a comprehensive literature review—part III: clinical applications, drawbacks, and mechanism of action. *J Endod* 2010;36(3):400-13.
5. Han L, Okiji T. Uptake of calcium and silicon released from calcium silicate–based endodontic materials into root canal dentine. *Int Endod J* 2011;44(12):1081-7.
6. Priyalakshmi S, Ranjan M. Review on Biodentine-a bioactive dentin substitute. *J Dent Med Sci* 2014;13(1):51-7.
7. Camilleri J, Sorrentino F, Damidot D. Investigation of the hydration and bioactivity of radiopacified tricalcium silicate cement, Biodentine and MTA Angelus. *Dent Mater* 2013;29(5):580-93.
8. Arora V, Nikhil V, Sharma N, Arora P. Bioactive dentin replacement. *J Dent Med Sci* 2013;12:51-7.
9. File BS. Active biosilicate technology, septodont. Saint-Maur-des-Fossés Cedex: R&D Department. 2010.
10. Kaup M, Dammann CH, Schäfer E, Dammaschke T. Shear bond strength of Biodentine, ProRoot MTA, glass ionomer cement and composite resin on human dentine ex vivo. *Head Face Med* 2015;11(1):14.
11. Grech L, Mallia B, Camilleri J. Investigation of the physical properties of tricalciumsilicate cement-based root-end filling materials," Dental Materials 2013;29(2):e20–e28.
12. Torabinejad M, White DJ (1995) Tooth Filling Material and Use. US Patent Number 5,769,638.
13. Butt N, Talwar S, Chaudhry S, Nawal RR, Yadav S, Bali A. Comparison of physical and mechanical properties of mineral trioxide aggregate and Biodentine. Indian Journal of Dental Research 2014;25(6).
14. Craig RG, Peyton FA. Elastic and mechanical properties of human dentin. J Dent Res 1958;37:710-8
15. Dr.Med.Dent.Markus Th.Firla. ,Direct pulp capping with bioactive dentine substitute
16. Mehmet Burak Guneser,Makbule Bilge Akbulut et al. Effect of various endodontic irrigants on the Push-out Bond Strength of Biodentine and Conventional Root Perforation Repair Materials; Journal of Endodontics, March 2013;39(3)380-384.
17. Torabinejad M, Hong CU, McDonald F, Pitt Ford TR. Physical and chemical [5]properties of a new root-end filling material. J Endod. 1995;21(7): 349-53
18. SeptodontBiodentine™ Active Biosilicate Technology™. Scientific file 2010.
19. Caron G, Azerad J, Faure MO, Machtou P, Yves B. Use of a new retrograde filling material (Biodentine) for endodontic surgery: two case reports. Int J Oral Sci. 2014;6(4): 250–53.
20. Mahmoud SH, El-Negoly SA, Zaen El-Din AM, El-Zekrid MH, Grawish LM, Grawish HM, Grawish ME. Biodentine versus mineral trioxide aggregate as a direct pulp capping material for human mature permanent teeth - A systematic review. J Conserv Dent. 2018 Sep-Oct;21(5):466-473.
21. Ahuja S, Surabhi K, Gandhi K, *et al*. Comparative Evaluation of Success of Biodentine and Mineral Trioxide Aggregate with Formocresol as Pulpotomy Medicaments in Primary Molars: An *In Vivo* Study. Int J Clin Pediatr Dent 2020;13(2):167–173.
22. Nayak G, Hasan MF. Biodentine-a novel dentinal substitute for single visit apexification. Restor Dent Endod. 2014 May;39(2):120-5.
23. Guneser MB, Akbulut MB, Eldeniz AU. Effect of various endodontic irrigants on the push-out bond strength of biodentine and conventional root perforation repair materials. J Endod 2013;39:380-4.

24. Pawar AM, Kokate SR, Shah RA. Management of a large periapical lesion using Biodentine as retrograde restoration with eighteen months evident follow up. J Cons Dent. 2013;16:573-5.
25. Kaur M, Singh H, Dhillon JS, Batra M, Saini M. MTA versus Biodentine: Review of Literature with a Comparative Analysis. J Clin Diagn Res. 2017 Aug;11(8):ZG01-ZG05.
26. Rajendraprasad D. Review on biodentine: A boon to pediatric dentistry. *Int J Oral Health Dent* 2019;5(2):55-8.