International Journal of Dentistry Scientific
Volume 2, Issue 1, Page 19-26, December 2024
ISSN: 3031-7142

The Use of Biodentin as a Treatment Material Choice for Primary Teeth : A Literature Review

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Article info: Received: 16-10-2024; Revised: 15-11-2024; Accepted: 11-12-2024; Publish: 30-12-2024

Abstract
Biodentin is a calcium silicate-based restorative material that is increasingly used in primary teeth treatment. This material has superior properties such as high biocompatibility, the ability to form secondary dentin, and antimicrobial properties, which make it a potential choice as a material in primary teeth root canal treatment. This literature review aims to review the use of Biodentin as a material of choice in primary teeth root canal treatment, considering the advantages, mechanisms of action, and clinical results that support its application. The results of the study showed that Biodentin has a faster setting time, good mechanical strength, and supports optimal pulp tissue regeneration. However, several limitations such as relatively high costs and limited long-term clinical trials need to be considered. Thus, Biodentin can be considered as an effective and safe alternative in primary teeth treatment, although further research is still needed to strengthen the clinical evidence of its use.

Keywords: Biodentin, Primary teeth, Dental materials, Biocompatibility

INTRODUCTIONS

Root canal treatment in primary teeth poses unique challenges due to their distinct anatomical and physiological structures. Primary teeth are essential for maintaining space for permanent teeth, chewing function, and the development of the child's jaw and facial structure. Hence, preserving primary teeth until their natural exfoliation is critical. Choosing the appropriate material for root canal treatment in primary teeth with pulp damage is crucial.

One material increasingly used in pediatric dentistry is Biodentine. Biodentine is a calcium silicate-based material that is biocompatible and bioactive. It has shown potential in root canal treatments due to its ability to promote hard tissue formation, encourage healing, and inhibit bacterial growth. Compared to

traditional materials like calcium hydroxide and Mineral Trioxide Aggregate (MTA), Biodentine offers distinct advantages, making it an attractive choice for primary teeth treatment.

This article delves deeper into the use of Biodentine as a material of choice for root canal treatment in primary teeth, considering its advantages, working mechanisms, and supporting clinical results.

METHOD

This study is a literature review with qualitative analysis. The literature used is in English and published within the last 10 years. It was sourced from three journal databases: PubMed, Elsevier, and Google Scholar. Literature searches were conducted using the keywords *"Biodentine"*, *"calcium silicate cement"*, *"vital pulp therapy"*, and *"primary teeth"*. Reference mining of identified articles was performed to locate additional relevant papers to enrich the findings. The cross-referencing process continued until no new articles were identified.

RESULTS AND DISCUSSION

Biodentine

Biodentine is a nanoparticle mineral cement (tricalcium silicate) designed to enhance the physicochemical and chemical properties of pulp capping materials. This material can be used to replace lost dentin structure, as a pulp capping material for both direct and indirect applications, for restoration of secondary caries, and for apexification. Biodentine offers advantages similar to BioAggregate, as it exhibits positive effects and stimulates reparative dentin growth on par with MTA when in contact with pulp tissue.[1]

Biodentine consists of a powder component containing tricalcium silicate, calcium carbonate, zirconium oxide, and a water-based liquid component containing calcium chloride as a setting accelerator and water-reducing agent. These powder and liquid components must be mixed to create a Biodentine paste ready for use.[2] The antibacterial properties of Biodentine are evident through the release of calcium ions during the hydrolysis of calcium silicate surfaces.

Additionally, Biodentine possesses excellent biological properties, making it ideal as a pulp capping material that can be directly applied to exposed pulp.[3]

Advantages of Biodentine:[2]

- It can be directly applied over exposed pulp.
- Does not require activation.
- Has a short setting time.
- Is easy to manipulate.

Table 1. Composition of Biodentine Powder and Liquid[2,4]

	Component	Function
Powder	Tri-calcium silicate (C_3S)	Main material
	Di-calcium silicate (C_2S)	Supporting material
	Calcium carbonate and oxide	Filler
	Iron Oxyde	Shade
	Zirconium oxyde	Radio-opacifier
Liquid	Calcium chloride	Setting accelerator
	Hydrosoluble polymer	Water reduction agent

Tabel 2. Advantages and Disadvantages of Biodentine[2, 3]

Advantages	Disadvantages
Mechanically stronger	Very sensitive to moisture
Not easily dissolved	Low fracture resistance
Faster setting time	Prices tend to be more expensive
Easy to manipulate	The radiodensity is quite low
Can be applied directly over exposed pulp	

Biocompatibility of Biodentine

Biodentine was developed using dental materials with excellent biocompatibility properties, specifically calcium silicate, which hardens upon interaction with water. This hydration process produces a gel of Calcium Silicate Hydrate (CSH) and, as part of the chemical setting process, also forms calcium

hydroxide. When it comes into contact with phosphate ions, compounds resembling hydroxyapatite are formed.[5]

Research by Mori G, et al. (2014) demonstrated the biocompatibility of Biodentine in subcutaneous tissue tests on rats. The study showed that inflammation occurred immediately after application, on day 7, and day 14, then decreased significantly after day 14. This indicates Biodentine's biocompatibility, as materials with reduced inflammation over time are classified as biocompatible.[1]

Furthermore, Biodentine's biocompatibility is supported by evidence that it does not exhibit cytotoxic activity and can induce the proliferation of human dental pulp cells (HDPC) and gingival fibroblasts. The viability and proliferation of fibroblasts occur from day 3 to day 7. Laurent et al. evaluated the cytotoxicity of Biodentine and MTA on human pulp fibroblasts and concluded that these materials do not affect cellular functions, confirming their biocompatibility and suitability for pulp tissue repair.[6,7]

Mechanism of Action of Biodentine

The setting reaction of Biodentine involves a hydration process, where the powder and liquid components are mixed using an amalgamator, resulting in a thick paste. The reaction between the powder and liquid forms a silicate hydrate gel and calcium hydroxide (CH). Calcium hydroxide dissociates into hydroxyl ions (OH^-) and calcium ions (Ca^{2+}), increasing the pH and Ca^{2+} concentration. This release of Ca^{2+} contributes to the material's bioactivity, its apatite-forming properties, and stimulates dental pulp cell differentiation, ultimately promoting the formation of a dentin bridge.[4]

Biodentine stands out due to its high Ca^{2+} release compared to other materials such as calcium hydroxide cement (CH), mineral trioxide aggregate (MTA), and resin-modified calcium silicate (TheraCal LC). The material's solubility plays a key role in the release of Ca^{2+}. Additionally, the release of OH^- creates an alkaline environment that supports tissue repair and forms a protective necrotic zone between the pulp tissue and the capping material. This necrotic zone shields pulp cells from the material's alkaline pH and facilitates the development of reparative dentin bridges.[4]

Moreover, Biodentine releases silicon ions (Si^{4+}) into the adjacent dentin, stimulating osteoblast proliferation and contributing to mineralization, collagen synthesis, and tissue cross-linking. Its ability to form hydroxyapatite crystals upon contact with phosphate-containing body fluids aids in sealing the direct interface between the tooth and the material, minimizing microleakage, and creating an environment conducive to reparative dentin formation.[4]

Clinical Applications

According to the manufacturer's guidelines, Biodentine is indicated as a restorative material for crowns and roots. Additionally, Biodentine is recommended as a temporary enamel restoration and as a base for sandwich restorations in deep carious lesions, deep cervical or radicular lesions, and vital pulp therapy, including direct pulp capping and pulpotomy. For roots, it can be used to treat root and furcation perforations, as well as internal and external resorptions. Biodentine is also recommended for apexification and retrograde filling.[4,8]

Direct Pulp Capping

Direct pulp capping protects exposed pulp and enhances pulp vitality by promoting the formation of tertiary dentin. The prognosis for direct pulp capping depends on the type of pulp exposure, with traumatic or iatrogenic exposures having better outcomes compared to carious pulp exposures.

Animal studies have demonstrated positive outcomes for Biodentine in direct pulp capping, though variations between animal and human responses require further investigation. These variations may be attributed to differing metabolic and immunological reactions in human tissues.

For pulp exposures in caries-free permanent teeth, both Biodentine and MTA have shown similar clinical results, with both materials promoting dentin bridge formation and minimal inflammatory pulp responses. In young permanent teeth with incomplete root development and carious exposure, Biodentine has demonstrated potential as a suitable capping material, achieving high success rates in maintaining pulp vitality.[4,8]

Pulpotomy

Pulpotomy is a procedure aimed at preserving the function and vitality of the pulp by surgically removing the exposed coronal pulp tissue. Formocresol is often used in this procedure due to its clinical success and ease of use, but concerns about its mutagenic, toxic, and carcinogenic risks have been raised. To address these risks, Biodentine can serve as an alternative to formocresol for pulpotomy procedures.

A 2019 randomized clinical trial evaluated the use of Biodentine for pulpotomy in primary molars of children, comparing its clinical and radiographic success rates with formocresol. While formocresol was chosen for its long-term clinical success, concerns about adverse reactions remain. MTA, another alternative, poses challenges in handling and setting time.[4,8,9]

The study reported high success rates for both Biodentine and formocresol pulpotomy techniques over 12 months, which were attributed to proper protocols, isolation, aseptic conditions, and correct material handling. These success rates align with previous studies emphasizing that Biodentine is a suitable alternative to formocresol in pulpotomy for primary teeth. Furthermore, Biodentine's dual role as both a dressing and restorative material offers clinical advantages over formocresol, which requires additional restorative materials in the pulp chamber.[9]

CONCLUSION

Biodentine is a promising material for root canal treatment in primary teeth due to its biocompatible and bioactive properties. It has the ability to regenerate hard tissue and inhibit bacterial growth, making it a superior alternative compared to some conventional materials like calcium hydroxide or MTA. Overall, the use of Biodentine as a treatment material for primary teeth yields good clinical outcomes, particularly in preserving the function of primary teeth until their natural exfoliation. However, the selection of this material should be tailored to clinical conditions while considering cost and the efficiency of the required treatment procedures.

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