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LITERATURE REVIEW/REVISIONE DELLA LETTERATURA

Biodentine: From biochemical and bioactive properties to clinical applications

Biodentine: dalle proprietà biochimiche e bioattive alle applicazioni cliniche

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Biodentine;
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Abstract Biodentine is a tricalcium silicate-based material designed as a permanent dentin substitute. It is biocompatible and bioactive material. Its interactions with both hard and soft tissues lead to a marginal sealing preventing marginal leakage and provide protection to the underlying pulp by inducing tertiary dentin synthesis. Unlike other dentin substitutes, Biodentine application does not require any conditioning of the dentin surface and the restoration sealing is provided by micromechanical retention as Biodentine penetrates into the dentin tubules forming tag-like structures. After setting, Biodentine can be cut and reshaped like natural dentin. It can also be bonded with different types of adhesives before finishing the final restoration with composite resin. Published clinical trials, histology of human teeth and clinical cases show that Biodentine has a wide spectrum of clinical applications as a permanent bulk dentin substitute in endodontics, in restorative dentistry, and pediatric dentistry as a possible replacement material of formecresol. This review brings a comprehensive understanding of Biodentine composition, preparation properties and the mechanism of interactions with hard and soft tissues. It explains the scientific mechanisms of the induction of these specific functions and illustrates the scientific basis beyond their clinical successful use. The article provides an overview of Biodentine clinical applications summarizing published clinical trials and reporting published clinical cases with this material in restorative and pediatric dentistry as well as in endodontics.

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PAROLE CHIAVE
Biodentine;
Cementi a base di trisilicato di calcio;
Sostituti della dentina;
Ricerca;
Applicazioni cliniche.

Riassunto Biodentine è un materiale a base di silicato tricalcico progettato come sostituto permanente della dentina. Si tratta di un materiale biocompatibile e bioattivo. Le sue interazioni con entrambi i tessuti duri e molli portano ad una sigillatura marginale in grado di prevenire l'infiltrazione marginale e forniscono una protezione alla polpa sottostante inducendo sintesi dentina terziaria. A differenza di altri sostituti della dentina, l'applicazione di Biodentine non richiede alcun condizionamento della superficie dentinale e la tenuta della restaurazione è fornito dalla ritenzione micromeccanica in quanto Biodentine penetra nei tubuli dentinali formando strutture di simili ai resin-tag. Dopo l'indurimento, il Biodentine può essere tagliato e rimodellato come dentina naturale. Può anche essere trattato con diversi tipi di adesivi prima di terminare il restauro definitivo. Studi clinici pubblicati, istologia di denti umani estratti e casi clinici dimostrano che Biodentine ha un ampio spettro di applicazioni cliniche, come sostituto permanente della dentina in endodonzia, in odontoiatria restaurativa e odontoiatria pediatrica. Questa review si propone di descrivere in maniera completa la composizione di Biodentine, le proprietà di preparazione e il meccanismo di interazione con i tessuti duri e molli. Essa spiega i meccanismi scientifici che caratterizzano queste funzioni specifiche e illustra la base scientifica del suo successo nell'utilizzo clinico. L'articolo fornisce inoltre una panoramica delle applicazioni cliniche di Biodentine riassumendo gli studi clinici e riportando i casi clinici pubblicati con questo materiale in odontoiatria restaurativa e pediatrica, così come in endodonzia.

Introduction

Over the past decades, search on restorative materials focused on replacing amalgams in small anterior restorations and on posterior restorations of moderate size by direct composite restorations. Opposed to amalgams, a micro-mechanical retention of resin composites can be achieved with these materials by applying different adhesives. However, some drawbacks have been reported with resin-based materials such as wear resistance under high stress, shrinkage upon polymerization leading to microleakage and toxic monomers release.[1,2] In order to protect the pulp from resin-based materials toxic components, Calcium hydroxide-based materials have been widely used in direct pulp capping procedures. 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.[3,4] The recent focus on biocompatible materials such as Portland led to the development of Mineral trioxide aggregate (MTA) as a root-end filling material and direct pulp capping. This material is mainly composed of tricalcium and dicalcium silicates.[5] When applied for pulp capping, it induces reparative dentin production leading to a regular tubular dentin bridge formation within 2 months with no signs of inflammation.[4] However, some shortcomings have been reported with this material. These are related to its long setting time of 2 h 45 min, weak mechanical properties and difficult handling properties.[6] Additionally, tooth discoloration has been reported when this material is used for revascularization.[7,8] Biodentine is a recently released tricalcium silicate-based material developed as a permanent dentin substitute to replace the damaged dentin.[9]

In this review, the material composition, preparation method and application, mechanical and physical properties will be described, its interactions with the soft and hard dental tissues will be explained and finally, Biodentine clinical applications based on published works will be reported.

Biodentine composition

Biodentine is a two components material. The powder is mainly composed of Tricalcium silicates. It also contains Di-Calcium Silicate as a second core material and Calcium Carbonate and Oxide as filler. The powder contains Zirconium oxide as a radio-opacifier. The liquid contains Calcium Chloride as a setting accelerator and a water reducing agent (Table 1). The presence of a setting accelerator allows the material setting in 12 min and the presence of a water reducing agent avoids the formation of cracks within the material. Such cracks are usually observed after setting of cements containing high percentage of water.[9] The material is prepared by adding 5 drops of liquid to the powder present in the capsule. These components are then triturated with an amalgamator for 30 s at 4000 rpm leading to the formation of a paste of creamy consistency. The preparation method and proportions between powder and liquid should

Table 1 Biodentine composition: two components: liquid and powder to be mixed with an amalgamator for 30 s at 4000 rpm.[9]

Powder	Role
Tri-calcium silicate (C_3S)	Main core material
Di-calcium silicate (C_2S)	Second core material
Calcium carbonate and oxide	Filler
Iron oxyde	Shade
Zirconium oxyde	Radio-opacifier
Liquid	
Calcium chloride	Setting accelerator
Hydrosoluble polymer	Water reducing agent

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