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Review

The Sealing Ability of Biodentine: A Literature Review

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Abstract

Microleakage, the passage of cariogenic elements between dental restorations and cavity walls, is a major concern in dentistry. Microleakage is a frequently seen factor contributing to the failure of dental restorations, tooth loss, and hypersensitivity. Biodentine, a tri-calcium silicate cement introduced in 2009 as a dentin replacement material, shows promise due to its composition, easy handling, faster setting time, antimicrobial properties and bioactivity. Biodentine has been stated to have broader clinical use than the Mineral Trioxide Aggregate (MTA) including pulp capping, pulpotomy, perforation repair, bifurcation lesion repair, internal and external root resorption, apexification, liner material for the coronal restorations as well as deep cervical and root cavities. Thus, the sealing ability of Biodentine is critical for dentin remineralization and restoration success. The objective of this review was to assess in-vitro studies that have focused on the microleakage of Biodentine in different applications and to suggest clinical recommendations.

Biodentine'in Sızdırmazlık Kabiliyeti: Bir Literatür Derlemesi

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Anahtar Kelimeler
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Öz

Mikrosızıntı, diş restorasyonları ile diş dokuları arasında karyojenik maddelerin geçişi olarak tanımlanır. Mikrosızıntı, diş restorasyonlarının başarısızlığı, diş kaybı ve aşırı hassasiyet sebeplerinden en sık görülen faktörlerdendir. 2009 yılında dentin yerine geçen restoratif malzeme olarak tanıtılan tri-kalsiyum silikat simanı olan Biodentine, bileşimi, kolay kullanımı, hızlı sertleşme süresi, antimikrobiyal özellikleri ve biyoaktivitesi nedeniyle umut vaat etmektedir. Biodentine, Mineral Trioksit Agregat'tan (MTA) daha geniş bir klinik kullanıma sahip olduğu bildirilmiştir; bunlar arasında pulpa kaplama, pulpotomi, perforasyon onarımı, bifurkasyon lezyonu onarımı, internal ve eksternal kök rezorpsiyonu, apeksifikasyon, koronal restorasyonlar için kaide malzemesi ve derin servikal ve kök çürükleri bulunmaktadır. Bu nedenle, Biodentine'in sızdırmazlık yeteneği, dentin remineralizasyonu ve restorasyon başarısı için kritiktir. Bu derleme, Biodentine'in farklı uygulama alanlarında mikrosızıntı üzerine çalışan in-vitro çalışmaları değerlendirmek ve klinik önerilerde bulunmak amacıyla yapılmıştır.

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Introduction

Microleakage is defined as a transport passage of emerging bacteria, liquids, molecules, and ions between the cavity wall and restoration material that cannot be observed clinically (1). Microleakage is one of the most common causes of restoration failure, tooth loss, and sensitivity (1,2). Cariogenic microorganisms colonized in the gaps between the restoration margin and the cavity wall as a result of microleakage may cause secondary caries and pulp pathologies (3). The main factors for microleakage are, the differences in the number of thermal expansion coefficients between the restorative material and the dental tissue, shrinkage of the polymerization material, abrasion of the material surface over time, inability to follow the required rules during material placement (1,4).

Biodentine is a water-based material containing tricalcium silicate. It has been introduced to dentistry as a "dentin replacement material" in 2009. It contains tricalcium silicate, dicalcium silicate, tricalcium aluminate and tetra-calcium aluminoferrite (5). Biodentine is produced in the form of a capsule with powder and liquid in ideal proportions. The powder content contains 80.1% tricalcium silicate, 14.9% calcium carbonate and 5% zirconium oxide. Calcium carbonate is for calcium filler content, improve biocompatibility and reduce setting time; zirconium oxide is used to increase radiopacity (6).

Biodentine has been stated to have broader clinical use than the Mineral Trioxide Aggregate (MTA) including pulp capping, pulpotomy, perforation repair, bifurcation lesion repair, internal and external root resorption, apexification, liner material for the coronal restorations as well as deep cervical and root cavities (5,7,8). Biodentine has been shown to have a greater ability to seal, a higher compression strength, a faster setting time (12 minutes), less colour change, and better antimicrobial properties in studies (9).

The sealing ability of Biodentine is critical for dentin remineralization and restoration success. This review aims to discuss current literature about the microleakage of Biodentine in different dentin treatments.

Sealing Ability on the Root-Canal Dentin

The sealing effect of Biodentine in both root and coronal dentin has been investigated in-vitro. Bani et al and El-Khodary et al found that Biodentine has the adequate sealing capacity as apical plug (10,11). On the other hand, Butt et al stated that the sealing capacity of the Biodentine has been found significantly higher than the MTA (Angelus) (12). It has been suggested that increasing the adhesion of Biodentine causes ion transfer and crystal growth in the dentinal tubules, resulting in occlusion of tubules with *de-novo* crystal formation. This leads to improved micromechanical adhesion, better seal, and reduced leakage (13).

In studies assessing microleakage through dye penetration, Biodentine exhibited significantly lower microleakage than MTA in some investigations (14-16), while in other studies, it surpassed MTA in this aspect (17-18). Mandawa et al. specifically compared the ProRoot MTA and Biodentine as retrograde filling materials using Rhodamin-B dye penetration, finding a superior marginal seal in the MTA group due to its higher hydrophilic nature and enhanced adhesion capability (15). Notably, under acidic storage conditions, no significant difference in impermeability was observed between ProRoot MTA and Biodentine (14).

Nepal et al made a spectophotometric analysis to detect the sealing ability of, Biodentine, glass ionomer cement (GIC) and MTA in retrograd root canal filling, resulting that MTA and Biodentine showed better sealing ability than GIC (19). According to these studies, Biodentine shows promise in terms of sealing ability and has easy handling characteristics and less time-consuming placement than MTA.

The permeability of the Biodentine is also affected by the solution in which the samples are stored. Camilleri et al investigated the microleakage of Biodentine on root dentin. Cracks in the Biodentin and changes in the microstructure were found in samples kept in a dry environment (20). According to Aggarwal et al, Biodentine kept in a Phosphate-Buffered solution (PBS), developed calcium-phosphate precipitates in the samples and this situation resulted in improved margin compatibility and impermeability (21).

Sealing Ability on the Coronal Dentin

There has been a limited amount of research conducted on the microleakage of Biodentine in coronal restorations. Koubi et al. conducted an in-vitro investigation to examine the microleakage values of Biodentine and RMCIS when applied under the composite using the open sandwich technique. The comparison was made with the glucose diffusion method. The average microleakage values of Biodentine and RMCIS were found to be similar after the study (22). The study conducted by Raskin et al. aimed to assess the microleakage values when Biodentine and Fuji IX glass ionomer cement were used as a base material together with composite filling, using the open sandwich method. The researchers reached the conclusion that there was not a statistically significant difference in microleakage between Biodentine and glass ionomer cement (23). In another research, Biodentine and Fuji IX cement were used in open sandwich method in class II cavities prepared in deciduous and permanent teeth. Dye penetration with basic fuchsin were used as assessment method and Biodentine showed significantly lower microleakage than glass ionomer cement (24). Such a controversy in the results of studies may be due to differences in the understudy samples or different methodology of studies.

Researchers observed an interactive interface between Biodentine and dentin, in which the tubules are occluded as tag-like structures. This layer has been interpreted as the presence of intra-tubular mineralization (7,25,26). This layer, according to Atmeh et al., was mediated by the cement's alkaline caustic effect on the organic component of the dentine, which facilitated mineral transfer, resulting in the formation of a "Mineral Infiltration Zone" (MIZ) (27). Therefore, MIZ can reduce microleakage and improve the remineralization potential.

Clinical Implication and Future Directions

This review highlights Biodentine's promising sealing capability on dentin. However, due to varying findings in different studies, additional research is needed, especially concerning Biodentine's efficacy in treating caries-affected dentin within deep cavities. To improve future studies, it is advisable to conduct clinical examinations and enhance standardization for a more robust evidence base.

Conflict of Interest Statement

The authors declare that they have no conflict of interest.

Authors Contribution Statement

The author (H.E.K) conducted the compilation independently and was solely responsible for the conception, research, and writing of the work.

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