

Are Bioactive Materials Necessary for Patients with Low Caries Risk? A Case Series of Incipient Enamel Carious Lesions in Anterior and Posterior Teeth

Materiais Bioativos são Necessários para Pacientes com Baixo Risco de Cárie? Uma Série de Casos de Lesões Cariosas Incipientes no Esmalte de Dentes Anteriores e Posteriores
¿Son Necesarios los Materiales Bioactivos para Pacientes con Bajo Riesgo de Caries? Una Serie de Casos de Lesiones Cariosas Incipientes en el Esmalte de Dientes Anteriores y Posteriores

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Abstract

Over the past decades, advancements in the understanding of caries disease mechanisms have led professionals to adopt the principles of Minimal Intervention Dentistry. These principles emphasize that management should primarily address the disease's etiological factors, allowing for the maximum preservation of remineralizable dental structures, ultimately enhancing tooth longevity and reducing disease burden. Meanwhile, numerous dental materials with bioactive properties have been developed, and current marketing strategies often present these materials as essential for effective treatment. Consequently, some professionals may perceive their approach as outdated if they do not incorporate bioactive materials. This study presents a series of cases involving incipient enamel carious lesions in both anterior and posterior teeth that were successfully treated regardless of the use of bioactive materials. The findings demonstrate that, when the disease's etiological factors are properly controlled, bioactive materials are not indispensable.

Descriptors: Composite Resins; Dental Enamel; Dental Caries; Fluorides; Tooth Remineralization.

Resumo

Nas últimas décadas, os avanços na compreensão dos mecanismos da doença cárie levaram os profissionais a adotar os princípios da Odontologia de Mínima Intervenção. Esses princípios enfatizam que o manejo deve abordar principalmente os fatores etiológicos da doença, permitindo a máxima preservação das estruturas dentárias remineralizáveis, o que, por sua vez, melhora a longevidade dos dentes e reduz a carga da doença. Enquanto isso, inúmeros materiais dentários com propriedades bioativas foram desenvolvidos, e as estratégias de marketing atuais frequentemente apresentam esses materiais como essenciais para um tratamento eficaz. Consequentemente, alguns profissionais podem perceber sua abordagem como ultrapassada caso não utilizem materiais bioativos. Este estudo apresenta uma série de casos de lesões cariosas incipientes no esmalte de dentes anteriores e posteriores que foram tratados com sucesso, independentemente do uso de materiais bioativos. Os achados demonstram que, quando os fatores etiológicos da doença são devidamente controlados, os materiais bioativos não são indispensáveis.

Descritores: Resina Composta; Cárie Dentária; Esmalte Dentário; Flúor; Remineralização Dentária.

Resumen

En las últimas décadas, los avances en la comprensión de los mecanismos de la enfermedad de caries han llevado a los profesionales a adoptar los principios de la Odontología de Mínima Intervención. Estos principios enfatizan que el manejo debe abordar principalmente los factores etiológicos de la enfermedad, permitiendo la máxima preservación de las estructuras dentales remineralizables, lo que, a su vez, mejora la longevidad dental y reduce la carga de la enfermedad. Mientras tanto, se han desarrollado numerosos materiales dentales con propiedades bioactivas, y las estrategias de marketing actuales a menudo presentan estos materiales como esenciales para un tratamiento eficaz. En consecuencia, algunos profesionales pueden percibir su enfoque como obsoleto si no incorporan materiales bioactivos. Este estudio presenta una serie de casos de lesiones cariosas incipientes en el esmalte de dientes anteriores y posteriores que fueron tratadas con éxito, independientemente del uso de materiales bioactivos. Los hallazgos demuestran que, cuando los factores etiológicos de la enfermedad se controlan adecuadamente, los materiales bioactivos no son indispensables.

Descriptores: Resinas Compuestas; Esmalte Dental; Caries Dental; Fluor; Remineralización Dental.

INTRODUCTION

Over the last decades, a significant transformation has occurred in the treatment of dental caries, driven by an improved understanding of the disease's underlying mechanisms^{1,2}. This knowledge has led many professionals to focus on the etiological factors of the disease, while also

treating the lesions using techniques that preserve as much dental structure as possible. This approach, known as Minimal Intervention Dentistry (MID), has proven successful due to the body's natural biological capacity to recover or repair at least part of the compromised dental tissue as long as the etiological factors of the disease are

removed, thus helping to reduce the burden of the disease¹⁻⁴.

Despite this well-established understanding, unnecessarily invasive procedures remain prevalent by some professionals⁵. This is often due to a lack of awareness regarding caries as a disease and the principles of MID¹⁻³. However, aesthetic motivations frequently drive these invasive treatments, leading to the disregard for tissue preservation³. Such practices can negatively affect the patients' biological response, compromise the biomechanical performance of treatments, and ultimately reduce the longevity of restorations^{6,7}.

Under this perspective, advancements in material science have introduced numerous bioactive materials lately⁸. These materials possess properties such as antimicrobial activity, enhanced remineralization, or fluoride ion release, which have shown promising results⁹⁻¹⁶. However, a common misconception among professionals is that the use of bioactive materials can completely replace the need for addressing patients' dietary and hygiene habits key factors in the successful management of dental caries.

Moreover, the marketing of bioactive materials often portrays them as indispensable for effective caries treatment, leading some dentists to believe that the absence of bioactivity in a material renders it inadequate. This perception conflates the treatment of dental caries as a disease with the management of individual carious lesions.

Therefore, to address this misconception, this case series aims to present practical, evidence-based, conservative approaches for managing incipient carious lesions confined to the enamel surface in anterior and posterior teeth. By using a diversity of products, this series highlights that the success of treatment lies not in the bioactivity of the materials but in the careful and strategic application of the principles of MID.

CASES REPRESENTATION

Despite the evidence supporting MID, patients are still often referred to dental appointments by other professionals or due to misconceptions about the presence of active carious lesions. Many patients mistakenly associate dark discoloration with caries while overlooking white spot lesions. While this is familiar to most dental professionals, the challenge remains to educate patients and avoid unnecessary drilling procedures. To ease the communication, the cases will be described using the International Caries Detection and Assessment System (ICDAS-II)^{17,18}.

CASE 1

A 15-year-old patient and his mother were concerned about the lesion on the palatal surfaces of the maxillary incisors, after a previous dental professional recommended to drill the darkened

tissue to treat the lesion (Figures 1,2 and 3). After explaining the etiology of dental caries, they agreed to address the discoloration with a resin-based sealant.

The tissue was firm, but the pits retained food residues and biofilm easily. Only one tooth displayed active white spot lesions around the pit. The lesions were classified as ICDAS 2 (inactive) on the left maxillary lateral incisor, ICDAS 1 (active) on the left maxillary central incisor, and ICDAS 1 (inactive) on the right maxillary central incisor. The patient also reported difficulty cleaning these surfaces. After cleaning the teeth with pumice, 37% phosphoric acid was applied for 30 seconds, rinsed with water, and a resin-based sealant (Fluoroshield, Dentsply) was applied and light-cured for 40 seconds.



Figure 1: Initial aspect of the palatal surface of the maxillary anterior teeth. Staining can be observed in the fissures.



Figure 2: Biofilm retention was noticed within the fissure on the palatal surface of the left maxillary lateral incisor. An inactive white spot lesion was observed surrounding the fissure of the left maxillary central incisor.



Figure 3: A resin-based sealant was applied to prevent the accumulation of biofilm which could lead to the formation of a carious lesion.

CASE 2

In the second case, a patient presented with white spot lesions on the left mandibular premolars and was particularly concerned about the aesthetics (Figures 4, 5 and 6). The lesions were classified as ICDAS 2, active, based on their humid appearance. A resin infiltrant was chosen to minimize or potentially eliminate the appearance of these lesions.



Figure 4: Initial aspect of the buccal surfaces of the two left mandibular premolars. White spot lesions can be observed in the cervical region.



Figure 5: After acid etching with 15% hydrochloric acid and drying with ethanol, the resin infiltrant was applied followed by light curing.



Figure 6: After removal of the rubber dam, the white spot lesion on the buccal surface of the left mandibular first premolar was almost imperceptible. However, on the second premolar, the white spot lesion remained visible.

After isolating the area with a rubber dam, the surfaces were cleaned with pumice and water. Following the manufacturer's instructions, 15% hydrochloric acid (Icon Etch, Icon, DMG) was applied twice for three minutes each time and then rinsed thoroughly with water. The surfaces were air-dried, and ethanol (Icon Dry, Icon, DMG) was

applied to remove residual water from the enamel pores. Finally, a resin infiltrant (Icon Infiltrant, Icon, DMG) was applied using its nozzle to ensure even distribution and penetration into the lesion. Excess material was removed, and the infiltrant was light-cured for 40 seconds. Post-treatment, the white spot lesion on the left mandibular first premolar disappeared, while the one on the second premolar was significantly reduced.

CASE 3

The third case resembled the first but with evident enamel breakdown, resulting in an ICDAS 3 classification (Figures 7 and 8). Despite the breakdown, the fissure's interior was firm upon probing. The lesion was treated using the same approach as in Case 1, with the same aforementioned resin-based sealant applied to protect and preserve the remaining structure.



Figure 7: Enamel breakdown located only in the pit and fissure area of the right mandibular second molar. The consistency of the area was firm, and no active white spot lesion was detected.



Figure 8: Despite the absence of an active lesion, a resin-based sealant was applied to prevent biofilm retention in the area.

In all three cases, drilling was successfully avoided by combining updated professional knowledge and patient compliance. This approach underscores the potential of minimally invasive techniques to deliver effective and conservative treatment.

DISCUSSION

The updated management of patients presenting with active dental caries lesions is strongly dependent on early diagnosis. However, beyond early diagnosis, management still relies

heavily on continuous education and orientation regarding dietary and hygiene habits^{1,2,19}. There is evidence that systems such as the ICDAS-II can assist clinicians in identifying incipient carious lesions more rapidly and adopting more conservative approaches that yield long-lasting results¹⁷.

Based on the ICDAS system, resin-based materials can serve as physical barriers that are particularly suitable for halting the progression of lesions. One of the mostly used resin-based materials are the resin sealants. Traditionally used for pits and fissures, recently their application has been extended to cases with ICDAS scores up to 3 (restricted to enamel), or even with score 4, as long as the lesion is limited to the outer third of dentin, with support from clinical trials^{3,20-22}.

Its mechanism is based on the fact that the sealant works as a physical barrier that prevents the contact of cariogenic bacteria with the carbohydrates from the diet, therefore these bacteria are unable to produce acids, halting the lesion's progression. Then, the saliva can gradually remineralize at least part of the lesion, and the dentin-pulp complex physiologically responds by producing sclerotic dentin, protecting and minerally reinforcing the remaining tooth structure.

The resin-based sealant used in this case series (Fluoroshield) has sodium fluoride in its composition. However, the amount of fluoride released by the material is so low that it may not have any additional benefit, thus behaving as a conventional resin-based, fluoride-free sealant^{10,12}. As reported by Wiegand et al.¹¹, the matrix, setting mechanisms and fluoride content are able to influence on the amount of fluoride being released, and Shen et al.²³ also reported that the source of fluoride incorporated in the material is also relevant. These characteristics may be the reason for a resin-based sealant such as Fluoroshield not be able to release considerable amounts of fluoride. Also, it is important to state that fluoride release is not proven to be effective at preventing the re-occurrence of caries,¹¹ therefore the etiological factors of the caries disease must always be addressed primarily.

Resin infiltration has become the preferred approach for smooth surfaces whenever possible, rather than just an alternative, particularly in areas with proximal involvement, yielding highly consistent results²⁴⁻²⁶. This approach, introduced several years ago, utilizes a low-viscosity monomer (triethylene glycol dimethacrylate - TEGDMA) to fill the pores in the enamel that work as diffusion pathways for the acid from bacteria. Thus, filling these pores hinders the progression of carious lesions²⁵. Research continues to explore monomers that not only serve this purpose but also provide additional benefits, such as incorporating bioactive agents or simplifying the application technique²⁶.

Another advantageous property of resin infiltrants is their ability to reduce the perception of white spot lesions due to their refractive index (~1.51) being similar to that of hydroxyapatite crystals in the enamel (~1.62), further increasing interest in this material, especially for anterior teeth²⁶.

Nevertheless, since the material is mainly composed of a fluid monomer, fillers that offer radiopacity are not added to the material, therefore infiltrated white spot lesions might be perceived as active lesions if the patient or the dentist do not know the area that was infiltrated. Therefore, dental records must be carefully filled and the patient must be properly informed to prevent any other hasty invasive treatment in the area.

Also, the cost of the infiltrant cannot be overlooked. Despite their appealing mechanisms, strategies like resin infiltration remain inaccessible for community services in many countries. Therefore, while this material presents excellent outcomes, the cost can limit its widespread use, often being used in areas in which other more accessible materials cannot be employed.

Despite the use of polymeric materials in certain areas, dietary and hygiene orientation must always be provided. The use of fluoride sources is still strongly recommended to keep the disease under control^{27,28}. In patients with low risk of caries exposed to community sources of fluoride such as the water, the twice daily use of 1,000-ppm fluoridated toothpaste is sufficient to control the disease. In those with high risk, along with the aforementioned toothpaste, highly concentrated vehicles such as varnishes can be used^{27,28}.

Considering that all patients were classified as low caries risk and adhered to treatment protocols, conventional (i.e. non-bioactive) polymeric materials were selected for all presented cases. These bioactive-free materials proved beneficial for the treatment of the lesions because the etiological factors were properly addressed over the course of the treatment. Indeed, some bioactive products are able to accelerate or improve the mineralization of a carious lesion with significant benefits^{13,15,29}. Yet, their use without properly identifying and addressing the issues that led to the development of the disease in the first place cannot be considered treatment for dental caries, and this strategy will likely fail.

Addressing and reversing the etiological factors of dental caries will always remain the cornerstone of any effective caries treatment.²⁹ When patients are engaged and benefit from continuous professional care, more conservative strategies can be effectively implemented^{3,18,30}.

Conservative approaches that consider the surface and extent of tissue compromise due to dental caries enable patients to experience early and long-term benefits safely. Therefore,

unnecessarily sacrificing sound or recoverable dental structure will only increase the burden of dental caries and, considering the repetitive restorative cycle, jeopardize the oral health of patients in the long-term.

CONCLUSION

Raising patient awareness and fostering active involvement in caries control are essential for the success of conservative treatment strategies. By focusing on early interventions tailored to the clinical characteristics of each case and guided by evidence-based practices, this approach demonstrates that effective management of incipient carious lesions confined to the enamel surface can be achieved without relying on bioactive restorative materials or invasive treatments.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest.

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