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CASE REPORT

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Early enamel affected lesions: benefits and limitations of simplified resin techniques

Lesões incipientes em esmalte alterado: benefícios e limitações das técnicas resinosas simplificadas

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ABSTRACT

Objectives: Advances in the early diagnosis and detection of enamel lesions have led to the development of commercially available adhesive resin-based systems designed to enable smart and minimally invasive treatment strategies. These systems are particularly valuable when the exclusive management of etiological factors and/or remineralization is insufficient or no longer effective. In addition to their management, carious lesions invoke strategies aimed at filling the subsurface porosities, whereas erosive tooth wear (ETW) requires the application of external protective measures that serve as a mechanical barrier to mitigate the effects of acidic attacks. **Case Report:** The present article presents two case reports involving young patients treated with simplified techniques, either with resin infiltration to recover white spot lesions caused by caries or ion-enriched systems to protect the external surfaces affected by ETW. Effective, reliable, and long-term outcomes depend on a thorough comprehension of dental surface alterations which guides the appropriate selection and use of simplified and conservative resin materials. **Conclusion:** The integration of early diagnosis with minimally invasive procedures, supported by a person-centered care approach, has demonstrated long-lasting and successful clinical outcomes.

KEYWORDS

Dental caries; Early diagnosis; Resin infiltrant; S-PRG particle; Tooth erosion.

RESUMO

Objetivos: Os avanços no diagnóstico precoce e na detecção de lesões de esmalte levaram ao desenvolvimento de sistemas adesivos à base de resina disponibilizados comercialmente, desenvolvidos para permitir estratégias de tratamento inteligentes e minimamente invasivas. Esses sistemas são particularmente valiosos quando o controle exclusivo de fatores etiológicos e/ou remineralização é insuficiente ou não é mais eficaz. Além de seu manejo, as lesões cariosas requerem estratégias destinadas ao preenchimento das porosidades subsuperficiais, enquanto o desgaste dentário erosivo (DDE) requer a aplicação de medidas de proteção externas que servem como uma barreira mecânica para minimizar os efeitos dos ataques ácidos. **Relato de Caso:** Este artigo apresenta dois relatos de caso envolvendo pacientes jovens tratados com técnicas simplificadas, seja com infiltração resinosa para reestabelecer lesões de manchas brancas por cárie ou uso de um sistema enriquecido com íons para proteger superfícies externas afetadas por DDE. Resultados eficazes, confiáveis e de longo prazo dependem de uma compreensão completa das alterações da superfície dentária, orientando a seleção adequada e o uso de materiais resinosos simplificados e conservativos. **Conclusão:** A integração do diagnóstico precoce com procedimentos minimamente invasivos, apoiados por uma abordagem de cuidado centrada na pessoa, demonstrou resultados clínicos duradouros e bem-sucedidos.

PALAVRAS-CHAVE

Cárie dentária; Diagnóstico precoce; Infiltração resinosa; Partículas S-PRG; Erosão dentária.

INTRODUCTION

The development of innovative materials and strategies for dental treatments has been effectively observed in recent years. This advancement is largely driven by investigations into the histopathological features of enamel and dentin alterations that induced major clinical challenges [1-3]. Simultaneously, the adhesive resin concept has served as a foundation, enabling a wide range of solutions for addressing these challenges [1-4]. To ensure effective approaches, early diagnosis is crucial for facilitating conservative interventions, while clear communication with patients is mandatory for achieving effective and long-lasting treatments [5-8].

Caries dysbiosis is no longer the sole primary focused event compromising dental tissues. Nowadays, other etiologies such as non-carious lesions, including erosive tooth wear (ETW), and developmental defects like fluorosis and molar-incisor hypomineralization (MIH) also demand preventive and minimally invasive interventions [1-3,9-11]. Differential and early diagnosis, regardless of the lesion's etiology, plays a critical role in minimizing or halting progression through the combined use of appropriate materials and the management of etiological factors.

In this context, alternative treatments involving materials capable of covering the external enamel surface garnered increasing interest. Commercially available options, such as resin infiltrants and barrier coat varnishes, are being utilized for minimal intervention procedures or as preventive strategies [10,12,13]. Notably, the expanding application of these materials beyond their original intended purposes, supported by evidence-based protocols, highlights their versatility and growing favorability [11,13]. Furthermore, their cost-effectiveness enhances their appeal, which remains an important factor to consider.

Resin infiltrants were first proposed in the 1960s and became commercially available after extensive experimental research [14]. A prominent example of this category of products is Icon (DMG, Hamburg, Germany), primarily indicated for treating inactive carious lesions on free and proximal surfaces [12,13,15]. Its mechanism of action involves removing the outer enamel layer to access subsurface porosities, which are then dried with alcohol and filled with the infiltrant material. This process halts the progression of demineralization through a physical-mechanical approach [12,13,15]. As an additional benefit, the resin infiltrant relies on its capacity to improve the esthetic appearance by reducing the difference in the refractive index (RI) between enamel filled with water (1.62) or air (1.00) and the infiltrant (1.52), resulting in a closer approximation to the natural enamel appearance [11-13].

Another clinical approach involves the use of resin coatings that release multiple ions, aiding in remineralization and strengthening of dental structures. In this context, these systems are based on monomers as delivery vehicles to achieve chemical benefits [16-18]. Among the available options, S-PRG/Giomer technology stands out as a system enriched with multi-ionic trilaminar glass particles nominated as S-PRG (surface pre-reacted glass-ionomer) [19,20]. As a xerogel, its external porous layer aids in the process of releasing multiple ions, including fluoride, aluminum, sodium, silicate, strontium and boron. Commercially, it is launched as PRG Barrier Coat (Shofu, Kyoto, Japan), which is a light-cured varnish applied as an adhesive coating layer. Once applied onto the enamel surface, it is primarily indicated as a dentin hypersensitivity agent and for remineralization of areas susceptible to dental caries [4,16,21]. For ETW, the PRG Barrier Coat can act as a mechanical barrier against acid action while simultaneously promoting remineralization and controlling pH buffering, likely reducing the erosive process [18,22].

Despite these benefits, it is essential to recognize that no material fully satisfies all clinical requirements. The effectiveness of these materials depends on their proper indications and the management of etiological factors. Professionals must be aware of the appropriate indications of these systems and carefully consider their benefits and limitations. The following case reports aim to discuss clinical considerations by comparing two promising resin-based strategies for managing early enamel lesions caused by different prevalent etiologies.

MATERIALS AND METHODS

The present series of clinical case reports was approved by the Local Ethical Committee (Protocol Number: 63544222.0.0000.5417).

Case report 1

An 18-year-old female patient was referred to the dental school expressing dissatisfaction with her smile. Through anamnesis and clinical examination, poor oral health and low motivation for proper care were observed. She admitted neglecting good oral hygiene habits despite being aware of the consequences, as highlighted by her previous dental history. We emphasized the importance of oral care and also recommended some treatment options for her, offering close support. She expressed a willingness to change. For a successful management, it was relevant to consider her reported history of gastric and dietary issues and the fact that she was recovering from a depressive disorder, which had affected her self-esteem.

Clinical examination revealed inflamed gums (Figure 1) and white lesions on the cervical areas of the maxillary anterior teeth (#13 - #23). Proximal restorations resulting from previous caries lesions were also observed. Additionally, irregular and worn incisal edges resulting from a combination of erosive and attrition factors were noted.

Figure 1 - Case 1. Initial view of the oral clinical condition presenting inflamed gums and white lesions on cervical areas of the maxillary anterior teeth.

The treatment approach began with the reinforcement of appropriate hygiene and dietary habits. Before planning the technical procedures, person-centered care was emphasized to ensure the patient's active involvement, which is essential for achieving long-term results. In this case, given the patient's history of depression, continuous encouragement and monitoring were critical for fostering engagement in her treatment. Initial restorative work involved repairing existing restorations and treating new cavitated carious lesions. Oral hygiene was reassessed during all follow-up visits.

At the subsequent appointment, cleaning with prophylaxis paste (Herjos, Vigodent, Rio de Janeiro, Brazil) using a Robinson brush (Microdont, São Paulo, Brazil) was performed for a general cleaning, subsequently facilitating a more accurate evaluation (Figure 2A). The white lesions were deemed suitable for resin infiltrant treatment, although some limitations were anticipated. The lesions were considered active, as evidenced by their notable rough and opaque surfaces (Figure 2B). While covering these areas with composite resin restorations were not discarded, the use of the infiltrant was preferred to minimize the invasiveness of the procedure.

A rubber dam was installed and therefore, the classical Icon (DMG, Hamburg, Germany) protocol of application was followed (Figures 3A to 3H). Icon Etch (15% hydrochloric acid) was applied for 2 minutes, followed by rinsing for 30 seconds and drying with air jets. Given the depth of the porosities, the etching step was repeated to

Figure 2 - Case 1. (A) Professional cleaning performed with prophylaxis paste; (B) Preoperative view suggesting active lesions.

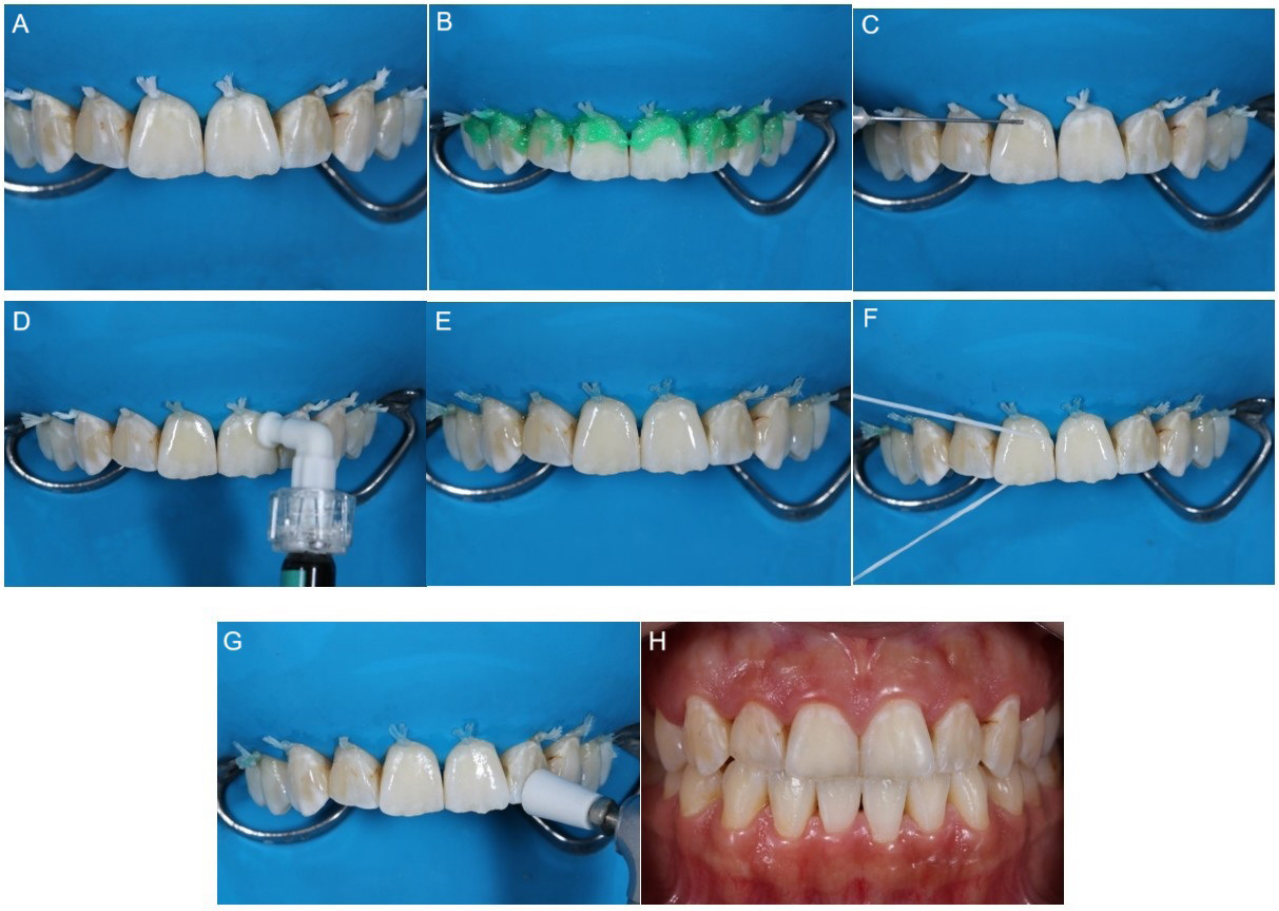

Figure 3 - Case 1. (A) Rubber dam positioned on the maxillary arch with ligatures performed to allow cervical exposure; (B) Application of hydrochloric acid (two 2-minute applications on all white lesions in the cervical areas) – Icon Etch; (C) Ethanol application – Icon Dry; (D) Infiltration with low-viscosity resin – Icon Infiltrant; (E) Removal of excess resin with dental floss, followed by light curing for 40 seconds; (F) Final aspect after resin infiltration; (G) Polishing procedures; (H) Postoperative view showing a significant reduction in the whitish perception.

ensure the adequate subsequent penetration of the infiltrant. Icon Dry (99% ethanol) was applied for 30 seconds, followed by air drying. The next step involved the application of Icon infiltrant for 3 minutes. Excess material was removed using a microbrush, and the area was light-cured for 40 seconds. A second application of Icon infiltrant was performed for 1 minute, followed by removal of any excess and additional 40-second light curing. Finally, polishing was completed using abrasive disks and points. By the end of the appointment, particularly after polishing, a significant reduction in the whitish appearance was observed.

Two weeks later, the patient returned for a follow-up. The resin infiltrant treatment appeared to be successful, stable and effective within its known limitations. The patient reported feeling motivated to continue treatment, which was further evidenced by the improved condition of her gums. Therefore, composite resin restorations were performed to enhance the buccal surfaces and correct tooth inclination, cover the worn incisal edges and repair the proximal restorations. The outcome reflects a successful combination of esthetic techniques, improving both the appearance and functionality of the teeth. The procedure and final appearance are illustrated in Figures 4A-C.

Case report 2

In this case, a 14-year-old female patient was referred to the dental school reporting episodes of dentin hypersensitivity. Although no structural dental compromise was observed, anamnesis revealed the habit of consuming an acid-based diet. Additionally, the patient had not attended a professional dental appointment for several years.

As in the previous case, the concept of person-centered care was applied. The patient and her parents received guidance regarding the necessary care and the diagnosis. Clinical examination revealed early signs of erosive tooth wear (ETW). Among the possible treatments, it

Figure 4 - Case 1. (A) Two-week follow-up and pre-restoration view; (B, C) Follow-ups at one week and two months, respectively.

was decided to perform a professional cleaning session using prophylaxis paste (PRG Pro-Care Gel, SHOFU, Kyoto, Japan) in the first appointment, followed by the application of PRG Barrier Coat (SHOFU, Kyoto, Japan) in the next session. This product is based on a self-etching system combined with S-PRG fillers which release aluminum, fluoride and strontium to reinforce the tooth structure. This combination helps to alleviate sensitivity while the coating acts as a temporary barrier against acidic attacks. Figures 5A-H illustrate the main steps of the recommended protocol.

First, the tooth surface was thoroughly cleaned and dried to ensure optimal adhesion. As a varnish, it is expected to dissolve, however, its resin component can extend its adhesion to the tooth surface for several weeks. The area was then isolated to prevent contamination during the application process. A thin layer of PRG Barrier Coat was applied with a disposable applicator from the cervical to the incisal third, ensuring uniform coverage. The excess in the proximal areas was removed using dental floss. After application, the material was left undisturbed for at least 3 seconds and light-cured according to the manufacturer's instructions (10 seconds). Finally, the patient was advised on post-application care, including maintaining good oral hygiene and avoiding certain foods that could compromise the coating during the initial phase.

Since this product is also indicated as a varnish for promoting remineralization and resistance to demineralization, its application was extended to other dental surfaces. Due to the impracticality of using a rubber dam in this case, moisture control was managed with cotton rolls and suction.

After one month, the patient reported a significant reduction in dentin hypersensitivity, even though some material detachment from the teeth was observed. The combination of dental structure reinforcement using a temporary physical barrier provided by the material with the reduction on the intake of acidic diet consumption contributed to an improvement in her quality of life several weeks later. The OHIP-14 questionnaire revealed a decrease in

Figure 5 - Case 2. (A) Preoperative view after cleaning procedures; (B) Application of a thin layer of PRG Barrier Coat (Shofu) on the dried buccal surface of the maxillary teeth; (C) Product application on the palatal surface of the maxillary teeth; (D, E) Application of PRG Barrier Coat on the buccal and lingual surfaces of the mandibular teeth, respectively; (F) Removal of excess material with dental floss, followed by light curing; (G) Final aspect after applying PRG Barrier Coat (Shofu); (H, I) One and four-month follow-ups, respectively.

hypersensitivity frequency, from "4-always" to "1-rarely". [23] After four months, the patient continued to report minimal or no painful discomfort with no complaints regarding the esthetic appearance (Figure 5I).

DISCUSSION

Contemporary dentistry focuses on the primary goal of providing long-term benefits to patients while considering the practical use of smart materials that facilitate professional handling and minimize technical errors. Achieving this balance requires a conservative approach supported by early diagnoses and patient compliance.

From this perspective, adhesive resin materials and new functional monomers have introduced diverse strategies for treating enamel and dentin [5,16]. The development of resin infiltrants, such as Icon, represents a remarkable advancement that has achieved optimal performance beyond the treatment of early white carious lesions [12,13,15]. The understanding of its mechanism extended its indication to include non-cavitated whitish lesions without structural damage [10,11,13]. While outcomes may vary, these treatments typically enhance esthetics, improve patient self-esteem, and promote treatment adherence. These aspects are critical for clinical success [10].

Cazzolla et al. [24] observed a successful four-year follow-up of a post-orthodontic patient who presented white spot lesions treated with Icon. Although no significant alterations were observed, there was no progression of early carious lesions. In addition, it is not uncommon to associate different procedures to enhance the overall performance towards promoting esthetic and conservative properties [25]. In particular, when esthetics is the main complaint of whitish lesions of enamel mal formation, enhanced improvements have been investigated [11]. Therefore, combined treatments

and/or variation of techniques have consolidated this material as promissory.

In recent years, bioactive materials have gained increasing attention among professionals and researchers. While the concept is not new, adhesive systems have driven the development of novel material categories with precise applications, redefining their purpose [26]. Managing erosive tooth wear has emerged as a predominant concern [27,28].

Therefore, approaches such as the use of self-etching systems like PRG Barrier Coat (Shofu) have experienced expanded indications beyond treating dentin sensitivity [21]. This product, based on Giomer technology, releases multiple ions due to the presence of S-PRG (surface pre-reacted glass) particles [19,20]. Studies have shown its efficacy across various scenarios, demonstrating promising results [18,21,29-32]. Agulhari et al. [32] described the successful use of PRG Barrier Coat combined with a composite resin restoration for a patient with ETW, reducing sensitivity and hindering erosive progression.

Both systems – Icon and PRG Barrier Coat – offer benefits in restoring functionality, while also providing esthetic outcomes depending on the case. Another important aspect is their easy application, making them practical for clinical use.

Lately, the literature has been demonstrating their efficacy and appropriate use. Kalisiri et al. [33] demonstrated that Icon and PRG Barrier Coat effectively seal artificial white-spot lesions, providing long-term protection and demonstrating great defense against microleakage. Mosquim et al. [34] highlighted the effectiveness of combining polymeric resin with inorganic ion-releasing fillers for managing dentin hypersensitivity under erosive conditions. Kaga et al. [18] emphasized that PRG Barrier Coat plays an important role in protecting against enamel demineralization.

The development and application of materials like Icon resin infiltrant and PRG Barrier Coat have expanded treatment possibilities, providing effective solutions for conditions such as early carious lesions, non-cavitated whitish lesions, and erosive tooth wear. In addition, variations of these materials and protocols cannot be ignored since they have achieved outstanding results, particularly when esthetics is a mandatory complaint [11].

However, clinical success depends not only on the inherent properties of materials and the skills of dental professionals, but also on the active participation and awareness of patients. Early diagnosis, patient compliance, and follow-up care remain pivotal in achieving long-term outcomes [8]. By integrating advanced materials with person-centered care, dentistry can meet both the clinical and emotional needs of patients, fostering improved oral health and quality of life.

CONCLUSION

Professional skills and the advantages offered by advanced materials provides significant support in managing and minimizing etiological factors. However, patient compliance remains essential to ensure effective results. Efficient and transparent communication with patients promotes their cooperation by addressing their needs and expectations. Regular follow-ups are essential for strengthening this relationship. Therefore, the integration of early diagnosis with the appropriate use of advanced materials is likely to ensure successful outcomes when the indications and applications are correctly aligned.

Author's Contributions

GGD: Conceptualization, Methodology, Investigation, Visualization, Resources, Data Curation, Writing – Original Draft Preparation, Writing – Review & Editing. MPC: Conceptualization, Methodology, Investigation, Visualization, Resources, Data Curation, Writing – Original Draft Preparation, Writing – Review & Editing. SKI: Visualization, Investigation, Supervision. LW: Conceptualization, Methodology, Validation, Investigation, Resources, Writing – Original Draft Preparation, Writing – Review & Editing, Visualization, Supervision, Project Administration, Funding Acquisition. MCG: Validation, Investigation, Resources, Writing – Original Draft Preparation, Writing – Review & Editing, Visualization, Supervision, Project Administration, Funding Acquisition.

Conflict of Interest

The authors have no conflicts of interest to declare.

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Regulatory Statement

The present study was conducted in accordance with all the provisions of the local human subjects' oversight committee guidelines and policies of the Bauru School of Dentistry – University of São Paulo, approval number 63544222.0.0000.5417.

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