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Case Report

Clinical management of white spot lesions induced by orthodontic treatment: a case report

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The use of fixed orthodontic appliances by conventional technique favors biofilm accumulation in adjacent brackets areas and, consequently, white spot lesions (WSL) development, diagnosed as active tooth enamel caries. Clinically, these lesions appear whitish and opaque, without superficial shine, and can affect aesthetics and self-esteem. **Aim:** The present study aimed to present and discuss the preventive and aesthetic treatment approach for a young patient with multiple WSL diagnosed as dental caries lesions, developed during orthodontic treatment with fixed appliance. **Methods:** An 18-year-old female patient was referred to the University Dental Clinic of the State University of Londrina for management of WSL located on the buccal enamel surfaces of the upper and lower teeth. Clinical and radiographic examinations revealed generalized active WSL on the buccal surfaces of both arches. After diagnosis and treatment planning, a combined approach was implemented, including mechanical biofilm control, remineralization therapy, tooth whitening, and enamel microabrasion. **Results:** The proposed therapeutic sequence yielded favorable outcomes, demonstrating that a conservative and effective clinical approach can be successfully applied for managing WSL in young patients after orthodontic treatment. **Conclusion:** The combined use of remineralization techniques, bleaching, and enamel microabrasion proved to be a viable, safe, minimally invasive, and cost-effective strategy to reestablish oral health and dental esthetics.

Keywords: Dental caries. Enamel microabrasion. Tooth bleaching. Tooth demineralization.

Introduction

White spot lesions (WSL) represent intrinsic dental alterations that can occur due to dental fluorosis, enamel development defects as hypoplasia or hypomineralization, and dental caries lesions as an iatrogenic side effect of conventional orthodontic treatment (COT) with fixed orthodontic appliances (FOA)[1-3].

It is estimated that 64.80% to 79.30% of patients undergoing orthodontic treatment may develop WSL due to dental caries at some point during the treatment[4,5]. This occurs due to the inherent characteristics of FOA, which favor dental biofilm retention in brackets adjacent areas and lead to an increased number of acidogenic bacteria in the oral cavity[2,4,6]. Additionally, individual behavioral factors, such as inadequate daily oral hygiene and an highly cariogenic diet can promote the onset and development of WSL caused by dental caries[6,7].

In patients undergoing COT, to reduce the risk of dental caries development and its consequences, the mechanical control of dental biofilm accumulation along with fluoride products that interfere in the demineralization-remineralization process is recommended[2,8], since demineralized dental enamel is susceptible to remineralization and to return to its normal conditions[9]. On the other hand, frequent exposure to fermentable sugars imbalances the demineralization-remineralization process and creates a favorable environment for the progression of WSL, due to dental caries into cavitation[4,9], which requires restorative intervention depending on the extent of the affected area, the severity level, and the patient's aesthetic needs.

The main aesthetic treatments for WSL due to dental caries described in literature include tooth bleaching[7,10], enamel microabrasion[7,11,12] and infiltration of the demineralized area with low-viscosity resin[7,10,12]. Tooth bleaching is a simple and low-cost procedure aimed at softening the color difference between WSL and the adjacent healthy enamel[12,13]. When combined with enamel microabrasion, clinical improvement in aesthetics is observed since the size of the WSL is reduced and the tooth color is altered[11,12]. Considering the context provided, the present study aimed to present and discuss the preventive and aesthetic treatment approach for a young patient with multiple WSL diagnosed as active dental caries lesions, developed during COT with fixed appliances.

Case report

This case report was written in accordance with the PRICE 2020 guidelines[14]. The patient was consulted and agreed to participate in the clinical case reported below, signing an informed consent form.

Initial oral clinical condition

After the completion of conventional orthodontic treatment and the myofunctional orofacial evaluation of the stomatognathic system's functions by a speech therapist specializing in Orofacial Motricity, an 18-year-old female patient was referred to the University Dental Clinic, State University of Londrina (COU-UEL) for treatment of WSL located on the enamel of the buccal surface of the upper and lower teeth.

During the anamnesis, relevant information was obtained to understand the clinical condition and diagnose the etiology of the WSL. When questioned, the patient reported undergoing COT with fixed appliances for 24 months, without receiving guidance on oral hygiene practices for mechanical control of dental biofilm. The patient also reported that only after the completion of orthodontic treatment and the removal of the brackets she was informed and referred for the treatment of the WSL. When asked about her personal complaint, the patient expressed aesthetic dissatisfaction with her smile due to the presence of the lesions.

On intraoral and radiographic examination (Gnatus, Timex 70C - operating at 70 kV and 8 mA, with a 2.5-mm aluminum filter and an exposure time of 0.25 seconds), WSL compatible with active generalized dental caries lesions were observed, located on the buccal surface of both arches (Figures 1 and 2). The depth of the WSL was diagnosed through the incidence of light beams on the palatal/lingual surface of the teeth, emitted by a light-curing device (Quazar, FGM) with the violet light check mode for this function (Figure 3). After diagnosis and treatment planning, in the first stage, the team chose strategies that could mechanically control dental biofilm, remineralize the tooth structure, and perform tooth bleaching to reduce the color difference between the healthy tooth structure and the WSL.

Figure 1. Initial clinical condition showing white spot lesions due to dental caries.

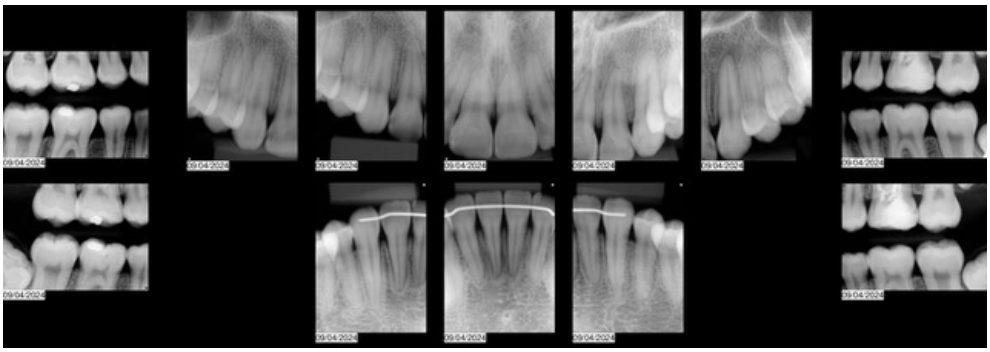

Figure 2. Radiographic examination of the upper and lower arch.

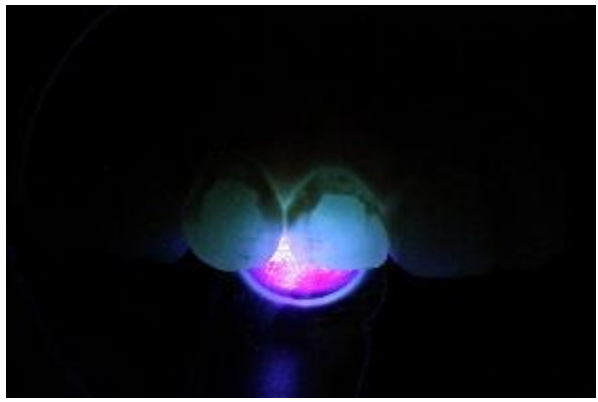

Figure 3. Incidence of light beams diagnosing the depth of white spot lesions.

Remineralization and tooth bleaching phases

In the first clinical treatment session, the following was performed: 1º) Prophylaxis of upper and lower teeth with pumice paste and water (Ultra-soft, American Burrs); 2°) Instruction and motivation for daily oral hygiene practices, with use of a high concentration of fluoride (5000 ppm F) dentifrice (Orthogard®, Colgate) when brushing teeth at night, throughout the treatment phase; 3°) Drying of the surface and application of fluoride varnish (Duofluorid XII®, FGM) on the active dental caries, advising the patient not to brush her teeth for 24 hours after the product application; 4°) Patient guidance on tooth decay, its etiology and consequences, emphasizing dietary counseling to reduce fermentable sugar consumption and the daily practice of individual preventive methods such as toothbrushing with fluoride dentifrice and flossing.

During the 2nd, 3rd, 4th, and 5th weekly clinical sessions, the patient returned for professional dental prophylaxis, application of fluoride varnish (Duofluorid XII®, FGM) on a dry surface, and photographic documentation. In the final varnish application session, after 30 days, the WSL were reassessed, revealing a smooth and shiny surface. Given the clinical condition observed, impressions of the upper and lower arches were taken during the same session using irreversible hydrocolloid (Jeltrate Plus, Dentsply Indústria e Comércio Ltda) to fabricate custom trays for at-home tooth bleaching.

In the 6th clinical treatment session, the following procedures were performed: 1) Testing and delivery of silicone trays for at-home tooth bleaching, along with guidance on the daily use of the 10% carbamide peroxide-based whitening agent (Whiteness Perfect®, FGM) for 3 hours per day over a period of 4 weeks. The 7th to 10th clinical sessions comprised weekly follow-up visits aimed at evaluating and supervising the at-home tooth bleaching procedure and reinforcing oral hygiene instructions.

In the 10th clinical treatment session, in-office tooth bleaching was performed with a 35% hydrogen peroxide-based product (Whiteness HP Blue®, FGM), according to the manufacturer's instructions. After the procedure, the patient reported mild sensitivity for approximately 24 hours, however, no intervention with desensitizing agents was required. The 11th clinical session was performed 60 days after the start of treatment, and a significant improvement in the color discrepancy between healthy tooth enamel

and some WSL was observed, primarily in the upper central incisors (Figures 4A and 4B). However, to address the patient's initial complaint and aesthetic need, which persisted after tooth bleaching, enamel microabrasion was proposed.

Figures 4A and 4B. Clinical condition of the upper and lower arches after remineralization and tooth bleaching phases, showing significant improvement in the color discrepancy between healthy tooth enamel and WSL.

Enamel microabrasion phase

After a week, the patient returned to begin the enamel microabrasion phase in the upper arch. The operative steps of the 12th clinical session involved: 1°) Rubber dam isolation of the operatory field involving the upper right second premolar and the upper left second premolar; 2°) Initial removal of the WSL with a multi-bladed bur with 30 blades (#90214FF, Labordental) coupled to the high-speed handpiece, under spray cooling (Figure 5); 3°) Application of a microabrasive product based on 6% hydrochloric acid and silicon carbide particles (Whiteness RM®, FGM), with abrasive rubbers (Microdont®) (Figure 6); 4º) Polishing of the vestibular surface of the microabraded teeth using a polishing paste (Diamond Excel®, FGM), with a felt disc (Diamond®, FGM); 5°) Application of neutral sodium fluoride (Flúor Care®, FGM). In total, five 10-second applications were performed on each tooth, with intermittent movements, according to the manufacturer's instructions. After each application, the teeth were washed abundantly with a water jet for clinical evaluation to determine if the procedure needed to be continued.

Figure 5. Initial removal of the WSL with multi-bladed bur with 30 blades.

Figure 6. Application of the microabrasive product with abrasive rubbers.

At the 13th clinical session, enamel microabrasion was performed on the lower arch, from the lower right second premolar to the lower left second premolar, using the same protocol described for the upper arch. Nonetheless, three applications of the microabrasive product were performed, as the lower teeth exhibited less aesthetic compromise compared to the upper teeth. In 30-day clinical follow-up, the patient reported being satisfied with the oral condition achieved (Figure 7), at which point she was advised to stop brushing her teeth with a high-fluoride dentifrice (Orthogard®, Colgate) and instructions regarding oral hygiene were shared again. Subsequently, the patient returned for clinical control after 90 and 120 days, periods in which improvements in clinical conditions obtained with the proposed treatment were evident (Figure 8).

Figure 7. Clinical condition after 30 days of enamel microabrasion.

Figure 8. Clinical condition after 4 months of enamel microabrasion.

Discussion

The evidence-based dental approach is essential to achieve satisfactory and minimally invasive aesthetic results in situations that require treatment of WSL due to active dental caries. This article discussed the importance of diagnosis and decision-making in a clinical case, where techniques for remineralizing the tooth structure were used combined with tooth bleaching and enamel microabrasion. These procedures enabled the restoration of the patient's health, aesthetics, and self-esteem through the preservation of the natural tooth structure and empowerment of the patient. Furthermore, an inseparable part of the treatment was the implementation of preventive measures, including oral hygiene education, the use of fluoride toothpaste, and dietary counseling to reduce the intake of fermentable sugars. These measures are essential for preventing the development of new carious lesions and ensuring the maintenance of the outcomes achieved. Nevertheless, it is crucial to emphasize that an accurate diagnosis is essential to guide the intervention, and each clinical case must be carefully evaluated to ensure the success of the proposed treatment.

From a histological point of view, early-stage dental caries lesions are characterized by areas of enamel subsurface porosity resulting from demineralization, without superficial cavitation, presenting a whitish, opaque clinical appearance without superficial shine[15,16]. These conditions are often observed in patients undergoing COT with fixed appliances, where the presence of brackets and accessories are inherent to the treatment, favoring the accumulation and prolonged retention of dental biofilm on the tooth surface. When combined with inadequate oral hygiene practices, they create a favorable environment for the development of WSL due to dental caries[6,11]. On the other hand, patients treated with aligners have a lower probability of developing WSL, as the treatment is completed in a shorter time, and the ability to remove the appliance allows the patient better control over oral hygiene[5]. In the clinical case reported, factors related to the use of FOA, treatment performed over 24 uninterrupted months, lack of instructions and motivation of the patient for daily oral hygiene practices, highly cariogenic diet during the treatment period, and the absence of individual and professional preventive therapies with fluoride repre-

sent potential factors that contributed to the development of WSL resulting from active dental caries.

The first stage of treatment included the use of remineralization strategies through the combination of products with a high concentration of fluoride: fluoride varnish (Duofluorid XII) for outpatient application, for 5 consecutive weeks, and fluoride dentifrice (Orthogard®) for daily use during brushing, at home. This choice considered efficacy, safety, ease of application, acceptance and patient awareness of the proposed treatment. It is known that fluoride varnish, due to its consistency and color, provides longer contact time with dental caries lesions and does not compromise aesthetics. The dentifrice, in turn, ensures adequate concentration of fluoride in the oral cavity between the varnish application sessions. Nonetheless, the immediate clinical results and those obtained after 120 days of follow-up showed traces of WSL caused by dental caries, probably due to the histological characteristics of the lesions and the depth of demineralization of the dental enamel.

Tooth bleaching with 10% carbamide peroxide was used in the at-home technique to reduce the color discrepancy between sound enamel and WSL. The selection of this bleaching agent was based on its safety for active lesions, antiseptic and bactericidal properties, ability to raise pH and not alter the characteristics of dental enamel[17,18]. After 4 weeks of use, an in-office tooth bleaching session was performed with 35% hydrogen peroxide. The literature does not demonstrate a significant difference in color change between the two techniques[19,20], although the use of high concentration hydrogen peroxide offers a greater probability of trans and immediate postoperative sensitivity to the whitening procedure[21], as reported by the patient. The association between remineralizing products and tooth bleaching resulted in significant aesthetic results, especially in the incisors. The persistence of some WSL, associated with the aesthetic complaint of a young patient represents both an aesthetic limitation and a clinical challenge for the dentist, presenting difficulties in resolution.

In light of this context, enamel microabrasion was proposed with the aim of achieving better clinical aesthetic conditions for the most evident lesions. The procedure presents advantages such as been a conservative, atraumatic and effective approach to improving the aesthetics of the smile, removing superficial stains from the enamel through the active application of a microabrasive product composed of an acid and an abrasive agent[22-24]. The depth of the WSL is a crucial factor in indicating the technique. The enamel microabrasion technique is more efficient when the lesions are located on the outermost surfaces of the enamel[24,25]. In the reported clinical case, total removal of some WSL, especially in the upper canines, was limited due to the depth of the lesions. To assist professionals in assessing the depth of the WSL, a violet light-emitting photopolymerization device was used in the clinical transillumination examination. Considering that demineralized enamel has a lower light transmission index compared to healthy enamel, WSL areas were diagnosed with better defined dark spots[24,26].

Prior to the application of the microabrasive compound based on 6% hydrochloric acid and silicon carbide (Whiteness RM, FGM), multi-bladed drills were used to remove stains from the enamel: one with 30 blades, for the initial removal. This initial removal

made it possible to reduce the number of microabrasive applications and the clinical time required for the procedure, in addition to enhancing surface regularization[26,27]. At each application of the microabrasive agent, the effectiveness of the treatment was evaluated with wet teeth, since the difference in the refractive index between air and tooth enamel is greater than that between saliva and tooth enamel[16,26,28]. In this sense, WSL due to dental caries visible in wet teeth may appear deeper than a lesion visible only on dry enamel[26,28].

The application of a microabrasive agent on the tooth surface promotes abrasion and demineralization of the enamel, resulting in a more polished, smooth and shiny surface, which alters its optical properties. The number of applications varies and depends on the severity of the enamel staining[26,28]. In the clinical case, the aesthetic improvement was evident during the follow-up. From this perspective, the choice of enamel microabrasion over low-viscosity resin infiltration can be justified due to the high cost of the product, which is often inaccessible for resolving cases in public higher education institutions. Furthermore, there is no sufficient clinical evidence available to support the use of these products for the removal of WSL caused by dental caries resulting from orthodontic treatment[29,30].

Ultimately, it is important to emphasize that aesthetic treatments were not prioritized over the promotion of the patient's oral health. In an initial stage, sessions were performed to adjust the oral environment and control the etiological factors of dental caries through dental prophylaxis, patient instruction and motivation for daily hygiene practices, as well as guidance on eating habits, development of dental caries, and the onset of WSL. Only after establishing satisfactory oral conditions, tooth bleaching and enamel microabrasion procedures were performed to provide aesthetic results that could impact the quality of life, well-being and self-esteem of the young patient.

In conclusion, the treatment of WSL resulting from dental caries, as an iatrogenic consequence of unadvised use of FOA, represents a clinical and aesthetic challenge with difficult resolution for the operator. This case report demonstrated the need to combine remineralizing techniques, tooth bleaching and enamel microabrasion to address the patient's aesthetic complaints. The final clinical results observed, both immediate and long-term, confirm that the proposed treatment was viable, safe, minimally invasive, cost-effective and suitable for restoring the patient's oral health and meeting their aesthetic needs. At last, it is essential that professionals understand the advantages and limitations of the materials and techniques used, as well as establish effective strategies for controlling dental biofilm and the consumption of cariogenic foods and encourage patients to practice oral hygiene to prevent WSL due to dental caries during COT with FOA.

Conflict of interest

The authors declare no conflict of interest.

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Data availability

Datasets related to this article will be available upon request to the corresponding author.

Informed consent statement

A signed informed consent form was obtained from the patient, authorizing the use of clinical information and images for publication purposes.

Author contribution

André Brunetto Bruniera: Conceptualization, Formal analysis, Diagnosis Investigation, Writing – review & editing. **Lucas Fernando Oliveira Tomáz Ferraresso:** Conceptualization, Formal analysis, Writing – review & editing. **Fernanda Tramontin Aguiar:** Formal analysis, Investigation, Visualization. **Paulo Eduardo Damasceno Melo:** Formal analysis, Investigation, Visualization. **Márcio Grama Hoeppner:** Conceptualization, Formal analysis, Diagnosis, Investigation, Visualization, Writing – review & editing. All authors actively revised and approved the final version of the manuscript.

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