Research, Society and Development, v. 11, n. 7, e56311730190, 2022
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v11i7.30190

Esthetic treatments for white and yellow/brown enamel stains

Tratamentos estéticos para manchas brancas/marrons presentes no esmalte dental

Tratamientos estéticos para manchas de esmalte blanco y amarillo/marrón

Received: 05/10/2022 | Reviewed: 05/21/2022 | Accept: 05/29/2022 | Published: 06/04/2022

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Abstract
In order to solve the dental aesthetic pattern of a patient, who has dental stains on the enamel surface, we carried out this case report where are presented the steps employed for bleaching of teeth with superficial yellow/brown enamel stains with carbamide peroxide and micrometric removal of hard white enamel stains using the enamel microabrasion technique. The worn of dental surface during enamel microabrasion technique was measured with a digital analysis, using a intraoral scanner. It was observed a surprisingly esthetic outcome as the superficial enamel stains were camouflaged by the at-home dental bleaching. Only the superficial white enamel stains that remained evident were removed by enamel microabrasion technique with a minimal average wear of 118 um of the dental enamel on all anterior teeth, showing to be a conservative technique. Dental bleaching can solve the discoloration of vital teeth, such as the superficial yellow/brown hard enamel stains, as well as can mask the superficial white enamel stains. But when necessary, enamel microabrasion technique is an effective minimally-invasive option that can also be adopted**.**
Keywords: Tooth whitening; Enamel microabrasion; Esthetics dental; Teaching.

Resumo
O objetivo deste relato de caso é apresentar as etapas empregadas para o clareamento de dentes com manchas superficiais de esmalte amarelo/marrom com peróxido de carbamida e remoção micrométrica de manchas de esmalte branco duro através da técnica de microabrasão do esmalte. O desgaste da superfície dentária durante a técnica de microabrasão do esmalte foi medido com uma análise digital, usando um scanner intraoral. Observou-se um resultado estético surpreendente, pois as manchas superficiais do esmalte foram camufladas pelo clareamento dental caseiro. Apenas as manchas superficiais de esmalte branco que permaneceram evidentes foram removidas pela técnica de microabrasão do esmalte com desgaste médio mínimo de 118 um do esmalte dentário em todos os dentes anteriores, mostrando ser uma técnica conservadora. O clareamento dental pode resolver a descoloração de dentes vitais, como as manchas superficiais de esmalte duro amarelo/marrom, bem como pode mascarar as manchas superficiais de esmalte branco. Mas quando necessário, a técnica de microabrasão do esmalte é uma opção minimamente invasiva eficaz que também pode ser adotada.
Palavras-chave: Clareamento dental; Microabrasão do esmalte; Estética dentária; Ensino.

Resumen
El objetivo de este reporte de caso es presentar los pasos empleados para el blanqueamiento de dientes que presentan manchas superficiales de esmalte amarillo/marrón con peróxido de carbamida y la remoción micrométrica de manchas duras de esmalte blanco mediante la técnica de microabrasión de esmalte. El desgaste de la superficie dental durante la técnica de microabrasión del esmalte se midió con un análisis digital, utilizando un escáner intraoral. Se observó un resultado estético sorprendente ya que las manchas superficiales del esmalte fueron camufladas por el blanqueamiento dental en casa. Solo las manchas superficiales de esmalte blanco que quedaron evidentes fueron eliminadas mediante la técnica de microabrasión de esmalte con un mínimo desgaste promedio de 118 um del esmalte dental en todos los dientes anteriores, demostrando ser una técnica conservadora. El blanqueamiento dental puede resolver la decoloración de los dientes vitales, como las manchas superficiales de esmalte duro amarillo/marrón, así como también puede enmascarar las manchas superficiales de esmalte blanco. Pero cuando sea necesario, la técnica de microabrasión del esmalte es una opción efectiva mínimamente invasiva que también se puede adoptar.
Palabras clave: Blanqueadores dentales; Microabrasión del esmalte; Estética dental; Enseñanza.

1. Introduction

Several clinical factors can lead to tooth color alteration, including (but not limited to): tetracycline and/or fluoride (fluorosis) intake during childhood, dental trauma, white enamel spots (with high hardness) common in patients after orthodontic treatment, among others (Leonard et al., 2003; Matis et al., 2006; Celik et al., 2017; Sundfeld et al., 2019; Sundfeld et al., 2019; Zimmerli et al., 2010; Franco et al., 2014; Sundfeld et al., 2007). Brown spot lesions are also commonly affected by exposure to certain foods and beverages that are rich in coloring agents (coffee, tea, soda, and chocolate) during the remineralization process (Al-Angari & Hara, 2016; Al-Angari et al., 2019; Borges et al., 2014). These spot color changes can significantly affect patients' esthetics, making these patients search for dental treatment. In some cases, dental bleaching is a good option that can "camouflage" those spots, which can be made at-home (with carbamide-peroxide-based products) (Haywood & Heymann, 1989), or in-office (with highly concentrated hydrogen peroxide products). Both protocols can be performed, if necessary and indicated, in association with the enamel microabrasion technique (Sundfeld et al., 2019; Sundfeld et al., 2019; Sundfeld et al 2007; Machado et al., 2016; Sundfeld et al., 2014; Pavani et al., 2018; Costa et al 2021).

Dental bleaching is a non-invasive treatment that consists in the interaction between reactive molecules produced by the degradation of hydrogen peroxide with pigments in the dental substrates. The carbamide peroxide used for at-home bleaching procedures is a chemical compound which dissociates into hydrogen peroxide and urea, in the presence of water and/or saliva; hydrogen peroxide is deemed as one the precursors of active dental bleaching (Joiner, 2017). Dental bleaching is a popular technique, of low cost, easy execution, which presents high effectiveness in altering tooth coloration (Haywood & Heymann, 1989), however, its success is dependent on the patients' collaboration (Sundfeld et al., 2019; Pavani et al., 2018). It is important for the professionals to precisely diagnose and to have knowledge of the bleaching mechanisms and biological aspects of tooth discoloration in order to correctly indicate the treatment, and educate their patients (He et al., 2012; Matis & Cochran & Eckert, 2009; de Geus et al., 2016; Luque-Martinez et al., 2016).

On the other hand, the enamel microabrasion technique is commonly employed for the removal of enamel irregularities or intrinsic hard stains of any color located on the superficial enamel layers, being considered an effective and safe procedure (Sundfeld et al., 2007; Sundfeld et al., 2016; Schincaglia et al. 2021; Garg et al 2022). It has been observed that the use of a tapered fine diamond bur to lightly abrade the stained area as the first stage of the technique (macroreduction) has resulted in less clinical time to perform the stain removal procedure, noting that the use of the enamel microabrasive product (microreduction) will complete the removal of the remaining stains, smoothening the enamel surface that was ground by the diamond bur. Anyway, with its application, there is a micrometric reduction of the enamel surface (Sundfeld et al., 2007; Sundfeld et al., 2014; Sundfeld et al., 2007). The enamel loss is minimal when compared to the total amount of the remaining tissue (Machado et al., 2016).

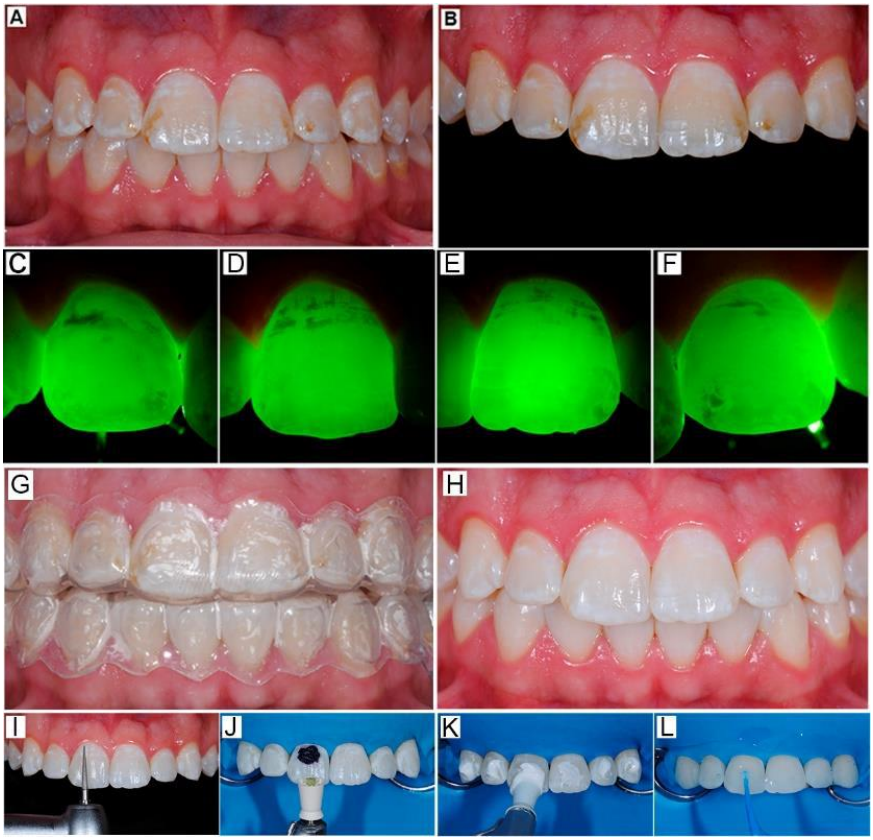
The aim for this present case report was to describe the clinical protocol for treating superficial yellow/brown enamel stains. The clinical case report procedures using at-home dental bleaching technique and the its association with enamel microabrasion procedures for the removal of superficial white enamel spots**.** The wear of the the dental enamel of the teeth submitted to application of the enamel microabrasion technique was performed through a digital analysis using a intraoral scanner.

2. Case Report

A 25-year-old male patient presented to appointment with a chief complaint of superficial white and yellow/brown enamel stains of hard texture (fluorosis-like) (Figure 1A and B), in upper and lower teeth. The patient has been submitted to orthodontic treatment for 3 years. Patient demonstrates poor dental hygiene, which contributed to the presence of spots due to de-remineralization process. After tooth prophylaxis and a carefully instruction of hygiene, the initial shade was selected by evaluating areas of enamel with no staining. The shade selected for upper incisors was 2M2 (VITA Bleachedguide 3D – MASTER, VITA Zahnfabrik, Bad Säckingen, Germany). At-home dental bleaching using 10% carbamide peroxide (Opalescence, Ultradent Products Inc., South Jordan, UT, USA) was prescribed and performed by the patient in both arches. To carry the bleaching product, custom-acetate trays (2.0mm in thickness) were fabricated with reservoirs in the buccal surface of incisors, canines, and premolars, on both arches. To create the reservoir, a block-out resin (LC Block-out, Ultradent Products Inc., South Jordan, UT, USA) was applied to the previously described surfaces of the stone cast with an approximate thickness of 0.5 mm, with a margin of 1.0 mm mesially/distally and 2.0 mm cervically. The patient was instructed to place two drops of bleaching product into each tooth section of the tray (from first molar to first molar) and advised to use both trays at night, for 6 to 8 hours per day (during their sleep). Six (6) syringes of bleaching product were used during the forty-five (45) days of bleaching treatment. Both trays were used simultaneously (Figure 1C).

It was observed that after dental bleaching, the superficial yellow/brown enamel stains were completely bleached, while hard superficial white enamel stains were partially camouflaged, remaining some more evident the hard white enamel stains (Figure 1D). This could be clearly observed by means of transillumination, using a special attachment (TransLume lenses, VALO, Ultradent Products Inc., South Jordan, UT, USA) of a polywave LED light curing unit (VALO, Ultradent Products Inc., South Jordan, UT, USA). Darker spots under transillumination suggest deeper stains (Figure 1E, 1F, 1G, 1H). After bleaching, the shade observed for upper incisors was 1M1 (VITA Bleachedguide 3D-MASTER, VITA Zahnfabrik, Bad Säckingen, Germany).

Figure 1 – (A and B) A 25-yearold male patient presenting superficial white and yellow/brown enamel stains of hard texture, in the upper and lower teeth. (C, D, E and F) Transilumination in the upper incisive teeth. (G) Upper and lower acetate custom trays positioned on the upper and lower arches. (H) After at-home dental bleaching. (I) Macroabrasion. (J) Application of microabrasive product. (K) Polishing with fluoridated prophylaxis paste. (L) Application of a 2% neutral sodium fluoride gel.



Source: Personal archive (2021).

Following this diagnosis, the enamel microabrasion was performed to remove the remaining and most evident white enamel stains on buccal surfaces of upper incisors and canines. Dental prophylaxis was performed using pumice and water on a rubber-cup attached to a slow-speed handpiece. Then, careful application of a super-fine tapered diamond bur (#3195 FF, KG Sorensen Indústria e Comércio Ltda) attached to a high-speed handpiece was performed under water-cooling to remove the most superficial layers of the stained white enamel (macroreduction) (Figure 1I). After rubber dam isolation, the enamel microabrasive compound (Opalustre, Ultradent Products Inc., South Jordan, UT, USA) was firmly applied for 1 minute against the tooth surfaces using a rubber-cup designed for this purpose (OpalCup, Ultradent Products Inc, South Jordan, Utah, USA), attached to a standard low-speed handpiece (Figure 1J). Two applications of the enamel microabrasive product, at intervals of 1 minute each, every 3 or 4 teeth (15-20 seconds per tooth) were necessary for the microabrasive product to produce a satisfactory esthetic appearance.

Teeth were rinsed with water between each interval. Eye protection during this procedure is crucial for the professional, dental assistant, and patient. After microabrasion applications, teeth were rinsed with water spray, and air-dried. Surfaces were then polished with a fluoride-containing paste (Herjos, Vigodent SA Indústria e Comércio, Rio de Janeiro, Brazil) (Figure 1K). A 2% sodium fluoride neutral-pH gel (Flugel, DFL, Rio de Janeiro, Brazil) was applied for 4 minutes on

the enamel surfaces that were subjected to microabrasion (Figure 1L). A considerably increase in esthetic was observed, the patient was satisfied with the results (Figures 2A and 2B).

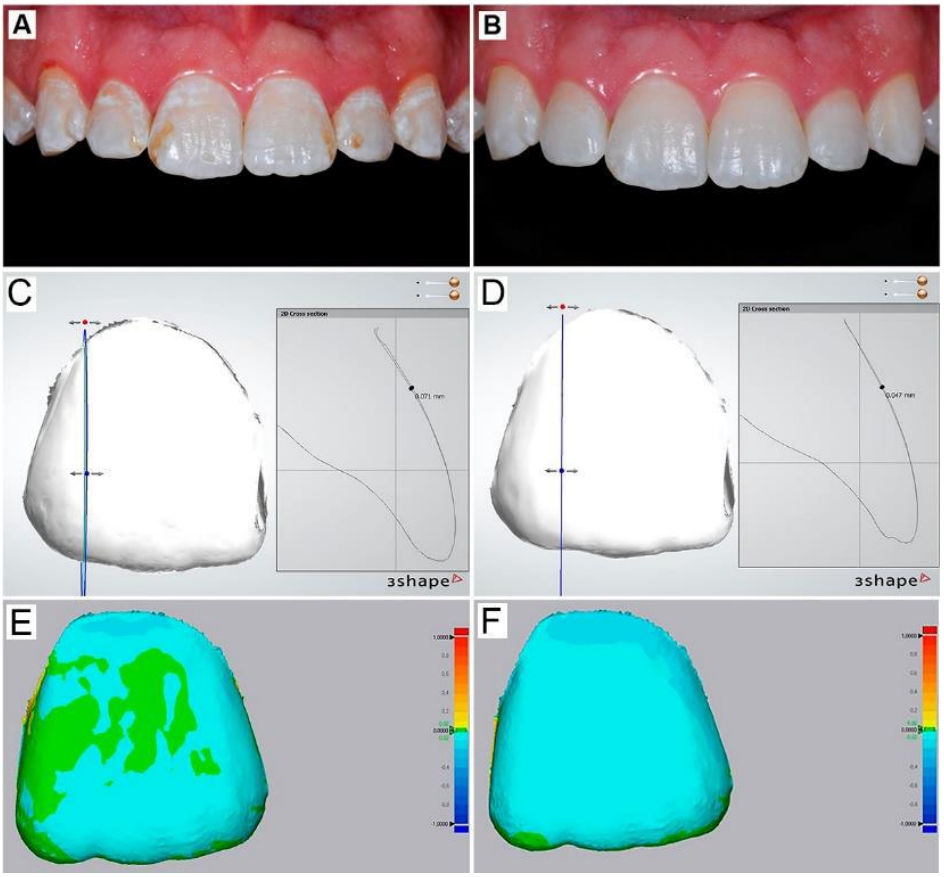
During the steps of the enamel microabrasion technique (macroabrasion and microabrasion) of the enamel and at the end of the procedure, the upper arch was scanned using a 3Shape intraoral scanner (Trios3, 3Shape, Copenhaguem, Dinamarca) to obtain digital models (3D), which were destined for analysis and quantification of enamel wear promoted in the teeth.

For the alignment of the digital models of each dental element, the open-source software Meshmixer (Meshmixer, Autodesk, inc) was used, taking into account the palatal surface of the anterior teeth, which has not undergone any clinical procedure or any change in morphology. For the quantification of wear, the analysis was performed using the 3SHAPE Software (3Shape viewer, Copenhaguem, Dinamarca) and the Geomagic Control X Software (3D Systems, Rock Hill, South Carolina, EUA). A tolerance of 0.025 mm was established for the overlap in the software.

In the 3SHAPE 3D viewer, it was observed the amount of removed of enamel stained through the macro and microabrasion performed in the canine and incisors teeth of both upper hemi arches. For this purpose, 3 regions of the stained area of each dental element were considered, corresponding its distal, mesial and central part. A total average for the wear caused by the macro and microabrasion of all measurements was made. The average wear of enamel of all teeth, for macro and microabrasion, were 68 and 50 micrometers, respectively. Thus, it was possible to observe an average wear of 118 µm after the completion of both steps on all upper anterior teeth (macro/microabrasion) (Figure 2C and 2D).

In the Geomagic Control X Software, it was also possible to observe and measure the areas of superficial dental wear, which are differentiated by the program with different colors. The green colored areas indicated that there was no wear on the enamel surface and the blue areas indicated that there was a superficial wear of the enamel surface (Figures 2E and 2F).

Figure 2 - (A) Initial frontal view of superficial white and yellow/brown enamel stains in the upper and lower arches. (B) After at-home dental bleaching and enamel microabrasion technique applications in the upper and lower arches. (C) Wear promoted after macroabrasion and (D) microabrasion through the 3SHAPE software. (E) Wear promoted after macroabrasion and (F) microabrasion through the Geomagic Control X program.



Source: Personal archive (2021).

3. Discussion

Dental enamel is a translucent tissue with predominant coloration in the range of “light yellow” to “grayish white”. The mature enamel is mostly mineral (96%) with traces of organic material and water (4%) (Raomán-Rodríguez et al., 2020). The stains observed on this clinical case are suggestive of dental fluorosis. However, the excessive fluoride intake at the time of tooth formation was discarded during anamnesis evaluation. The patient has reported poor dental hygiene, with a diet that included high consumption of chocolate and soft-drinks during childhood and young adult. Furthermore, the patient was orthodontically treated for 3 years. Also, the natural aging process can lead to “darkening” of the dental structure by systemic and/or local factors. It is arguable that this may be caused by the continued production of secondary dentin and/or the addition of organic material into enamel from the environment (Borges et al., 2014; Araújo et al., 2015).

In fact, young enamel behaves like a semipermeable membrane, allowing a low water flow along with small molecules through the enamel pores (Raomán-Rodríguez et al., 2020). The terms “fluorosis-like stains” and “enamel demineralization” have also been reported to describe the chromatic changes on the surface of the dental enamel resultant from disturbances in the enamel mineralization process (Killian, 1993; Croll, 1998). These different factors possibly contributed to the formation of non-esthetic, hard, smooth, and glossy yellow/brown enamel stains, which were possibly incorporated into the

demineralized enamel during the remineralization process (Al-Angari & Hara, 2016; Al-Angari et al., 2019; Borges et al., 2014; Araújo et al., 2015).

Dental bleaching procedure using carbamide peroxide is a great esthetic treatment option, however, it should be performed under professional supervision and in patients with healthy dentition. Furthermore, dental bleaching should not be performed on patients with exposed dentin tissue, since it could lead to dental sensitivity, both during and after the procedures. In contact with the dental substrate, carbamide peroxide dissociates in urea and hydrogen peroxide (H_2O_2) molecules. The hydrogen peroxide also dissociates into water (H_2O) and reactive oxygen species (ROS), or oxidative free radicals, that permeate through enamel and dentin tissues. These ROS have the ability of breaking large molecules (chromophores) into smaller molecules, which changes their optical properties and configurations, resulting in a "lighter" tooth structure (Goldberg, Grootvelt & Lynch, 2010., 2010; Eimar et al., 2012; Kwon & Wertz, 2015).

Stains within dental tissues (enamel and/or dentin) are often caused by organic compounds (Kwon & Wertz, 2015). In that sense, hypomineralized enamel presents a higher content of organic matter, thus a statistically higher content of carbon when compared to normal enamel. This suggests that the bleaching treatment of superficial yellow/brown enamel stains is more effective, since it is more effective in organic compounds rather than inorganic (calcium and phosphate, for example) (Eimar et al., 2012). For this clinical case, the at-home dental bleaching using carbamide peroxide was very efficient and (surprisingly) has completely bleached the superficial enamel yellow/brown enamel stains. Furthermore, the at-home dental bleaching led to satisfactory results for both arches, with adequate shade alteration. It is important to mention that the enamel microabrasion technique was unnecessary for the superficial yellow/brown enamel stains due to the bleaching effectiveness. However, the enamel microabrasion technique was performed on the most evident white enamel stains located mainly in the cervical and incisal regions of the upper incisors and canines teeth, respectively. The white enamel stains are suggestive of poor oral hygiene during orthodontic treatment.

When analyzing the amount of dental enamel removed by the action of the super-fine diamond bur (macroabrasion) and the application of the microabrasive product, it was possible to observe an average wear of 118 µm enamel on all teeth submitted to the microabrasive technique (macro and microabrasion), corresponding at 68 µm resulting from the application of the super-fine diamond bur, during the removal of the more superficial stained enamel layers and 50 µm from the application of the microabrasive product, during the removal of the deeper stained enamel layers as well as to the regularization of the superficial grooves, resulting from the preview application of the super-fine diamond bur.

These results showed that enamel microabrasion technique leads to minimal and micrometric removal of dental enamel when compared to the remaining amount of that tissue (Sundfeld et al 2007; Machado et al., 2016). The cervical region presents approximately 300-400 micrometers of thickness and, the present analysis showed that the microabrasion preserves the most part of the enamel tissue (Fragell et al., 2010). Also, the resulting surface is considerably regular, smooth, and glossy (abrasion effect), (Sundfeld et al., 2007; Sundfeld et al., 2016; Atsu et al., 2005), resultant from a mineral compaction caused by the erosive and abrasive action of the microabrasive compound (Sundfeld et al., 2019; Donly, O'Neill & Croll, 1992; Segura, Donly & Wefel, 1997). Indeed, previous long-term clinical follow-ups (Sundfeld et al., 2014; Sundfeld et al., 2007), have reported that the careful application of a superfine diamond bur (macroabrasion) prior to the use of the microabrasive agent is optional and can reduce the chair-side clinical time and the use of a smaller amount of microabrasive material. This was observed for the clinical case presented, since only two or three 1-minute applications of microabrasive product were required to obtain the desired esthetic effect.

We apply the super-fine diamond bur before applying the microabrasive product; having observed, since then, that when it is applied, during the wear of the most superficial layers of the stained enamel, with extreme care and with smooth and slow movements, it is able to collaborate with the maintenance and/or obtaining an adequate contour of the buccal face.

Certainly, it can be achieved by adequate visualization of the enamel stained área, during its application. In sequence, the removal of the deepest stains and the excellent regularization of the tooth enamel surface are achieved by applying the microabrasive product.

The bleaching of yellow/brown stains was satisfactory and, even, unexpected. The authors believe that this bleaching effectiveness was due to the depth of the stains. It is important to bear in mind that the analysis of the depth is the more important than the color alteration. If the stains were deeper, the bleaching procedures would only alter the color from yellow/brown to opaque white, which would still require the enamel microabrasion for complete removal. Thus, bleaching enamel superficial yellow/brown stains were an effective and conservative approach for the improvement of patients' dental esthetic.

4. Conclusion

Dental bleaching is a great clinical procedure option to solve the discoloration of vital teeth, mainly in the presence of superficial yellow/brown hard enamel stains. Furthermore, the dental bleaching can mask the superficial white enamel stains, reducing the need for physical removal of dental tissues. However, if necessary, enamel microabrasion is an effective minimally-invasive option. In summary, the clinician should carefully evaluate each case for proper diagnosis and treatment planning.

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