Quantitative and Qualitative Evaluations on Enamel after White Spot Lesion Treatment with Microabrasion-In Vitro Study

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Abstract

Aim: In this study, it was aimed to quantitatively and qualitatively determine enamel loss after microabrasion treatment in white spot lesions of varying severity caused by orthodontic treatments.

Material and Method: 60 caries-free human mandibular premolars, which were recently extracted before orthodontic treatments and preserved in 0.1% aqueous thymol solution, were used for this study. Three groups were generated based on the severity of decalcification using an artificial caries solution: mild, severe, and cavitated lesions. While the abrasion was applied to the distobuccal surfaces of all samples, the contralateral side served as a control. Each sample image was captured using a stereo microscope and camera, and the enamel loss and demineralization depth were measured comparatively. The change of surfaces in all groups was also examined with a Scanning Electron Microscope (SEM).

Results: The highest enamel wear after microabrasion was found in the cavitation group as 300.52±87.47 µm. There was no difference between the moderate and severe lesion groups on the experimental side; however, the cavitation group was statistically significant due to the higher enamel abrasion depth (p:0.0002).

Conclusion: This study reveals that the microabrasion method is a safe and effective therapy option for mild to severe lesions.

Keywords: Microabrasion • White Spot Lesion • Enamel Loss • SEM

Introduction

White Spot Lesion Formation (WSL) is a state of imbalance between enamel demineralization and remineralization when plaque remains on the enamel surface for a long time, and is particularly common in many patients treated with fixed orthodontic appliances [1]. After the placement of fixed orthodontic attachments on teeth, the natural cleaning process of the lips on the teeth decreases, and oral hygiene is negatively impacted by the prolonged orthodontic treatment. This can lead to plaque accumulation around the bracket and band, resulting in enamel demineralization [2,3]. WSL, which are frequently seen in anterior teeth in the first 7 to 12 months of fixed orthodontic treatments, are mostly seen in the adolescent age group [4].

Different treatment methods have been tried by researchers for the treatment of WSL. Noninvasive measures, such as remineralization or resin infiltration, and invasive measures, such as composite make-ups or the placement of laminates may be preferred for the treatment [5-7]. Upon examining the literature on WSL treatments, a conservative technique called microabrasion therapy is frequently mentioned [1,8]. This treatment involves the use of a low-speed hand tool or a wooden scraper to perform a combination of mechanical erosion and an abrasive agent [9,10]. Initially, a mixture of 18% Hydrochloric Acid (HCl) and pumice was used on the treatment of mild lesions [9]. It has been observed that this application has been performed at different lesion depths, at different times and in different application forms since it was to be used [8,11,12] .

The microabrasion technique creates an image that closely resembles the normal enamel surface due to the erosive and abrasive effects it produces. This can be explained as, micro-abrasion can cause a small amount of enamel loss as it is meant to remove the stain and produces a vitreous luster, an extremely smooth enamel surface [13].

Numerous factors such as the quantity of applications, applied force, and duration of application have been found to contribute to enamel wear during microabrasion [14]. Several studies have examined the extent of enamel loss resulting from microabrasion procedures. [11,15,16]. Nevertheless, the teeth utilized in these studies did not exhibit any decay or WSL.

The objective of this study was to assess both the quantitative and qualitative outcomes of enamel reduction following microabrasion in white spot lesions that exhibit different degrees of severity.

Material and Method

This study has Usak University ethics committee approval.

Teeth selection and specimens' preparation

In this study, 60 new caries-free human upper premolars extracted for orthodontic indication were used. Excluded from the study were teeth with any restoration, white-brown demineralized areas, fractures, abrasions, or microcracks.

Teeth extracted for orthodontic procedures were cleaned and disinfected, stored in 0.1% aqueous thymol solution and used within a maximum of one month. To expose the labial surface, all samples were buried in a resin block containing wax following a thorough cleansing with water, the exposed tooth surface was polished for 10 seconds with fluoride-free pumice using a rubber cup and washed with distilled water and dried with oil-free air.

Vesitubular surfaces of all tooth surfaces were covered with liquid impermeable wax except control areas (Figure 1). At room temperature, neutral pH, and continuous circulation, the teeth were kept in artificial saliva solution. The contents of this solution can be summarized as follows; 20 mmol/L of $NaHCO_3$, 3 mmol/L of NaH_2PO_4, and 1 mmol/L of $CaCl_2$. To simulate oral conditions, all teeth were soaked in an artificial saliva solution for 12 hours prior to being subjected to the artificial caries solution. Throughout the study, the solution was replaced every other day, and each group was cycled in a separate beaker containing the solution. An artificial caries solution was prepared containing 2.2 mmol/L of Ca^{2+}, 2.2 mmol/L of PO^{4-}, and 50 mmol/L of acetic acid with a pH of 4.4. The following day, the artificial saliva and caries solution were exchanged every 12 hours to simulate oral conditions during the experiment. For 37 days at room temperature, teeth were rotated twice daily for one hour between constant circulation and the threat of artificial saliva and caries. The teeth were properly dried after alternating between artificial saliva and artificial caries, and the erosion was visually assessed. The procedure was repeated until the desired lesions were formed on each tooth. The severity of the lesions was evaluated based on the scoring system proposed by Gorelick et al [2] and categorized as mild, severe, and cavitated levels (Figure 2) [1].

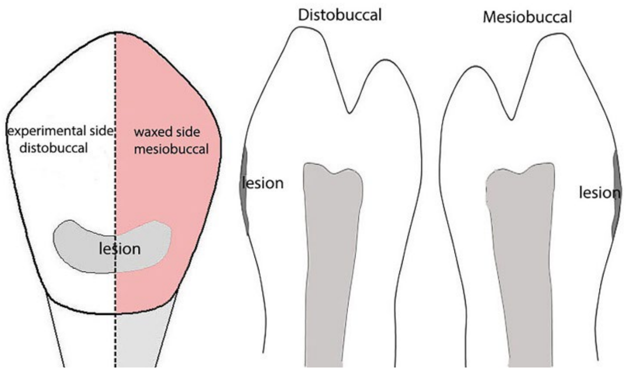

Figure 1. Methods of tooth preparation.

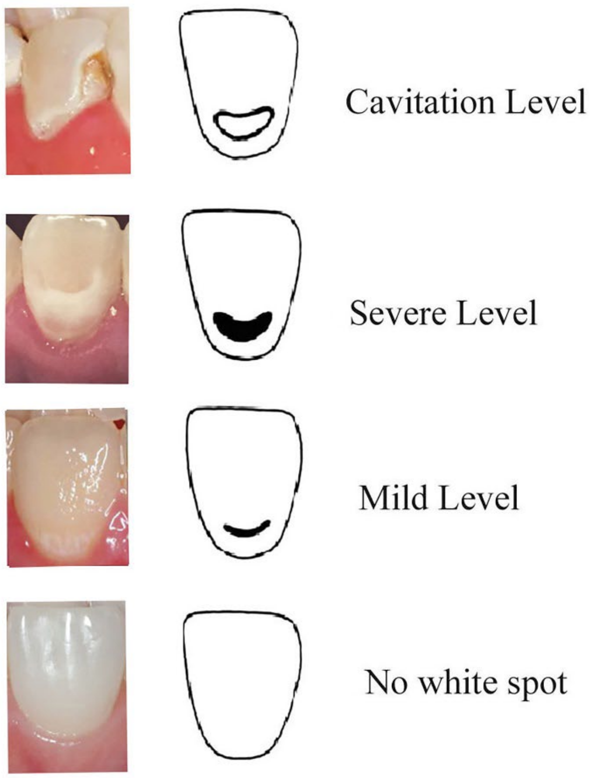

Figure 2. Visual representation of the groups based on Gorelick et al's classification [2]

Enamel conditioner

The abrasive gel was formulated using a blend of fine powdered pumice, glycerin and 18% hydrochloric acid sourced from Ak-Kim in Izmit, Turkey. The components were mixed well in a glass container, with a weight ratio of 2:1 for powder to acid. Then, a few drops of glycerin were added gradually until the mixture reached a smooth and fluid consistency, forming a gel-like substance [3].

Techniques

The micro-abrasion procedure was exclusively performed on the distobuccal aspect of the teeth, with the opposing side serving as the control surface. The samples were divided into 3 primary groups, consisting of 20 teeth each, and subsequently subdivided into 3 sub-groups based on the degree of lesion severity. The microabrasion groups were classified as M1 (mild lesion), M2 (severe lesion) and M3 (cavitation), while the control groups were designated as C1 (mild lesion), C2 (severe lesion) and C3 (cavitation).

To ensure consistent pressure during the microabrasion process, all procedures were carried out by a single investigator (STY) (Figure 3 to Figure 5). The abrasive gel mixture was applied to the teeth using an electric toothbrush, which had been modified by shortening the outermost bristles to form a more compact brush head that would fit more snugly onto the tooth surfaces [3]. The toothbrush was operated at a low speed, with each tooth undergoing the procedure three times for duration of two minutes each. After treatment, the teeth were rinsed for one minute. To analyze the surfaces, the crowns were bisected mesiodistally from the occlusal to cervical using the same disk (Batch No. 0976, S.S. White Limited, Harrow, England), and only the buccal surfaces were kept for further examination.

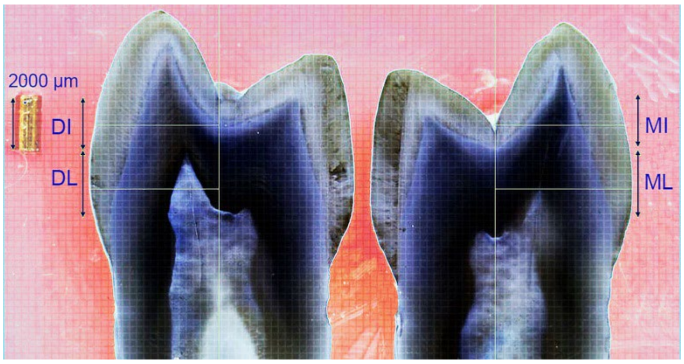

Figure 3. Images of teeth with mild level white spot lesions. ML: Mesial part of the surface with the lesion, MI: Mesial part of the intact surface, DL: Distal part of the surface with the lesion, DI: Distal part of the intact surface.

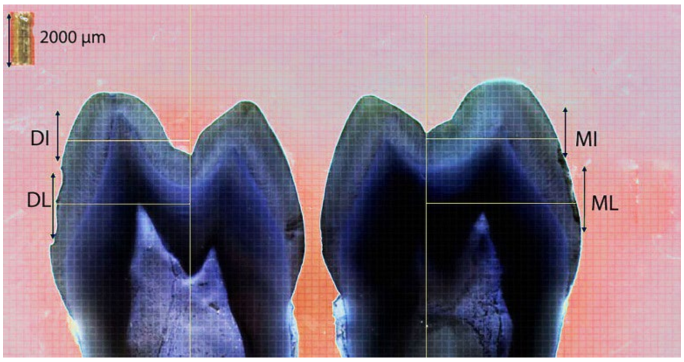

Figure 4. Images of teeth with severe level white spot lesions. ML: Mesial part of the surface with a lesion, MI: Mesial part of the intact surface, DL: Distal part of the surface with a lesion, DI: Distal part of the intact surface.

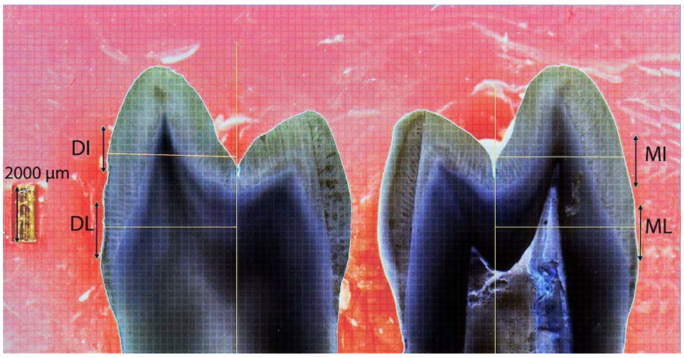

Figure 5. Images of teeth with cavitation level white spot lesions. ML: Mesial part of the surface with a lesion, MI: Mesial part of the intact surface, DL: Distal part of the surface with a lesion, DI: Distal part of the intact surface.

Enamel loss assessment steps

To evaluate enamel loss, a plastic excavator was used to gently remove the wax coating from the tooth surfaces. The teeth were then sectioned in half buccopalatinally through the lesion center using a low-speed diamond saw (Isomet 1000, Buehler, Lake Bluff, IL, USA) with continuous water cooling. Stereo microscopy and a camera (Axio Imager.A2 and Axiocam 105 color, Carl Zeiss Microscopy, LLC, NY, US) were used to capture microphotographs from the mesiobuccal and distobuccal regions of both the lesion and intact enamel within the same crown areas. The microabrasion technique was applied to the cervical and middle third of the distal crown for the lesion, while the cervical and middle third of the mesial crown were left untreated (Figure 1). Using Axiovision 4.8.2 software (Carl Zeiss Microscopy, LLC, NY, US), the depth of demineralization was measured in micrometers for all three levels of lesion severity, namely mild, moderate, and severe (refer to Figures 3-5, respectively).Following the microabrasion procedure, SEM images were captured for all groups (mild, moderate, and severe) using the MK III Cambridge Stereoscan (Figures 6 to Figure 8).

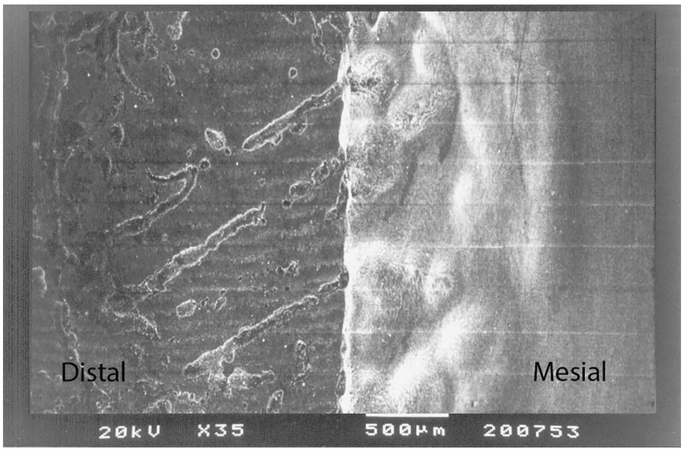

Figure 6. SEM image after microabrasion in the mild lesion group. Mesial: mesiobuccal side and Distal: disto buccal side.

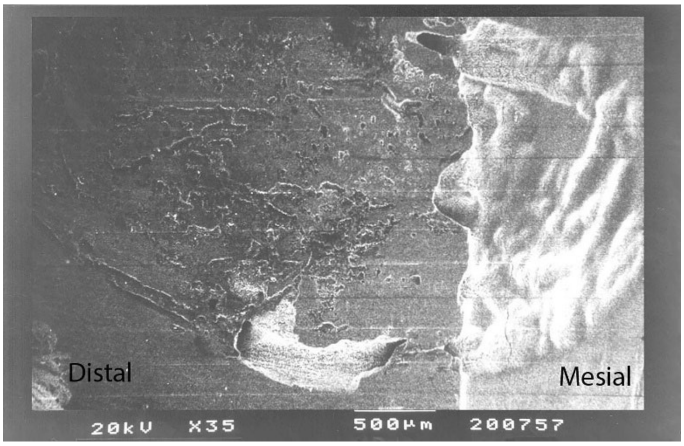

Figure 7. SEM image after microabrasion in the severe lesion group. Mesial: mesiobuccal side and Distal: disto buccal side.

Figure 8. SEM image after microabrasion in the cavitation group. Mesial: mesiobuccal side and Distal: disto buccal side.

Statistical analysis

Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 28.0 for Windows, developed by IBM, SPSS Inc. in Chicago. To determine the Method Error (ME), ten teeth were randomly selected and measured twice using Dahlberg's formula ($ME=\sqrt{\sum d2/2n}$, where d is the difference between two measurements and n is the number of double measurements). The ME was calculated as 0.237.

The Kolmogorov-Smirnov test was used to assess normal distribution of the data. One-way ANOVA was then conducted, followed by Post-Hoc Tukey test to compare between groups. A t-test was conducted to examine the variations between the measurements of the microabrasion and control groups in each sub-group.

Results

Table 1 presents the mean values of enamel wear depth, measured in micrometers (µm), for all groups. The group with the most substantial enamel wear was found to be M3, exhibiting a mean of 300.52 µm ± 87.47 µm. No significant changes were found in M1 and M2 groups after microabrasion, but a significant increase in enamel wear depth was observed in M3. The C1 and C3 groups showed similar levels of enamel wear, whereas C2 showed slightly lower wear. The one-way ANOVA and Post-Hoc Tukey test revealed a significant difference among the groups after microabrasion, with M3 showing the greatest difference.

In this study, microabrasion was performed on only one side of the teeth. It was observed that the treatment resulted in a smoother surface and a region without enamel prisms. The SEM images indicated that all groups with WSL exhibited tooth surfaces that were substantially smoother than their initial state (Figures 6 and Figure 7). Nonetheless, microcavities persisted in the cavitation group (Figure 8).

Table 1. Mean and standard deviation of depth of the enamel wear after microabrasion and control group with subgroups depend on severity of WSLs.

Lesions		**Microabrasion (M) groups** (µm)		**Control (C) groups** (µm)	**d**	**p**
Mild	M1	111.11 ± 66.67	C1	101.58 ± 34.91	9.52 ± 5.74	0.27
Severe	M2	113.22 ± 46.55	C2	89.94 ± 45.54	23.28 ± 30.55	0.053
Cavitation	M3	300.52 ± 87.47	C3	106.87 ± 40.20	193.65 ± 60.23	0.0002*
ANOVA		<.001		0.49		

Discussion

Many studies have investigated the results of physical and chemical agents, as well as laser applications, on the enamel surface during the removal of stains. However, studies focusing on the long-term aesthetic outcomes of these methods are scarce. Resin infiltration technique has recently gained attention as a promising approach to improve the visibility of lesions, as reported in various studies [17,18]. One study showed that the color of resin-infiltrated WSL changed, especially after consuming food that causes staining [6].

Microabrasion can be used as a treatment option for WSL that lead enamel wear due to their erosive and abrasive nature [10]. The extent of enamel wear resulting from microabrasion has been the subject of interest and investigation in the literature [11,12,19]. However, recent studies suggest that the procedure is a conservative treatment alternative when enamel erosion is minimal and not noticeable during clinical examination [10]. All the studies that reported enamel wear after microabrasion were conducted using non-caries teeth, to the best of our knowledge. Enamel wear may differ after microabrasion in teeth with WSL because of slightly softer regions in the surrounding enamel surfaces [1]. In this *in vitro* study, the amount of enamel wear on teeth with varying degrees of WSL severity was measured after exposure to microabrasion. At the same time, changes in the enamel surface after microabrasion and enamel quality were evaluated.

Microabrasion has shown successful results in treating mild and severe WSL, with enamel wear within acceptable levels of 111.11 µm in the mild group and 113.22 µm in the severe group. It has been recommended as a treatment option for superficial enamel discoloration up to a maximum depth of 100 µm. The enamel thickness on the buccal surface of premolars was measured at approximately 1 mm in various populations [20]. Based on the findings of this study, microabrasion was considered a safe and conservative treatment method, with only a 10% reduction in enamel thickness after treatment for both mild and severe cases [12]. Enamel abrasion amounts were not statistically significant in all groups of microabrasion groups except cavitation. Another finding was that although the enamel was demineralized, the enamel surface was still intact in mild and severe groups after microabrasion. This may be why similar results were obtained between microabrasion and control for mild and severe groups.

Studies evaluating the amount of enamel loss after microabrasion with HCL and pumice have reported similar results [21]. Although Meireles et al. [11] reported less enamel wear (94.6 µm) than other studies, a greater amount of enamel wear (139 µm and 386 µm) has been reported in the literature [22]. The potential erosive and abrasive effects are influenced by several factors, including the applied force and rotations per minute [23,24]. It is likely that the discrepancy in results is due to variations in the microabrasion application techniques used in the different studies. The quantity of enamel loss during microabrasion can be influenced by the number of applications and the applied pressure [14], Sundfeld et al [19], found that after 3 and 15 applications, enamel wear was 25 and 140 µm, respectively. In our study, all samples were subjected to a 2-minute application, which was longer than the application durations used in previous studies [11,12]. However, increasing the application duration did not result in increased enamel loss, and our results were similar to those of previous studies. When examining the enamel loss caused by WSL in the cavitation group, it was found to be about three times higher than in the control area. This is thought to be due to the softer enamel being more easily removed. The depth of the defect is the most important factor in the success of enamel microabrasion [10]. Lesions with initial cavities may experience less enamel loss after microabrasion. Therefore, the results of this study do not suggest that "microabrasion is not a suitable treatment option for cavitated WSL. However, special attention should be paid to patients with cavitated WSL. This study's clinical relevance is demonstrated by the finding that microabrasion is sufficient to flatten the lesion by removing the enamel surface, which is consistent with previous studies [1, 11]. The SEM images obtained from this study show that microabrasion can create very smooth surfaces in all lesions, except for cavitated lesions. The technique may provide a conservative alternative for some patients who may have decided to have a porcelain or composite lamina restoration because of their tooth discoloration [16]. This treatment method offers several significant advantages: It is affordable, requires minimal chair time, and can be easily performed by the orthodontist.

Conclusion

In contrast to previous research on the topic, this study provides evidence that microabrasion is a secure and efficient approach for treating moderate to severe cases of WSL. However, microabrasion should be approached with special care, as approximately one-third of the enamel thickness is lost in the cavitated WSL group.

References

1. Gelgör, I., et al. "A scanning electron microscope investigation into white spot lesion removal with microabrasion approach." *Turkiye Klinikleri J Dental Sci.* 15 (2009): 11-17.
2. Gorelick, L., et al. "Incidence of white spot formation after bonding and banding." *Am J Orthod.* 81.2 (1982): 93-98.
3. Gelgör, I.E. & Büyükyilmaz, T. "A Practical Approach to White Spot Lesion Removal." *World J Orthodon.* 4.2 (2003).
4. Nayak, U.A., et al. "White Spot Lesions on Teeth during or Postorthodontic Treatment: A Knowledge Based Cross-sectional Survey of Dentists." Journal of Clinical & Diagnostic Research. 2021;15(9).
5. Yadav, P., et al. "A comparative quantitative & qualitative assessment in orthodontic treatment of white spot lesion treated with 3 different commercially available materials-*In vitro* study." *J Clin Exp Dent.* 11.9 (2019): e776.
6. Alqahtani, S., et al. "Colour stability of resin infiltrated white spot lesion after exposure to stain-causing drinks." *Saudi J Biol Sci.* 29.2 (2022): 1079-1084.
7. Sampson, V., & Sampson, A. "Diagnosis and treatment options for anterior white spot lesions." *British Dent J.* 229.6 (2020): 348-352.
8. Caglaroglu, M., & Gelgor, I.E. "Microabrasion technique for treatment of demineralization after debonding." *J Clin Orthod: JCO.* 46.12 (2012): 734-737; quiz 753.
9. Croll, T.P. "Esthetic correction for teeth with fluorosis and fluorosis-like enamel dysmineralization." *Journal of Esthetic and Restorative Dent.* 10.1 (1998): 21-29.
10. Pini, N.I., et al. "Enamel morphology after microabrasion with experimental compounds." *Contem Clin Dent.* 6.2 (2015): 170.
11. Meireles, S.S., et al. "Surface roughness and enamel loss with two microabrasion techniques." *J Contemp Dent Pract.* 10.1 (2009): 58-65.
12. Rodrigues, M.C., et al. "Minimal alterations on the enamel surface by micro-abrasion: *in vitro* roughness and wear assessments." *J Appl Oral Sci.* 21 (2013): 112-117.
13. Donly, K.J., et al. "Enamel microabrasion: a microscopic evaluation of the "abrosion effect"." *Quintessence Inter.* 23.3 (1992).
14. Dalzell, D.P., et al. "Microbrasion: effect of time, number of applications, and pressure on enamel loss." Pediatric Dentistry. 17 (1995): 207-207.
15. Tong, L., et al. "The effects of etching, micro-abrasion, and bleaching on surface enamel." *Journal Of Dental Res.* 72.1 (1993): 67-71. [Google Scholar] [Cross Ref]
16. Segura, A., et al. "The effects of microabrasion on demineralization inhibition of enamel surfaces." *Quintessence Int.* 28.7 (1997).
17. Hammad, S.M., et al. "Evaluation of color changes of white spot lesions treated with three different treatment approaches: an in-vitro study." *Dent Press J Orthodon.* 25 (2020): 26-27.
18. Tavares, M.I., et al. "Resin infiltration in white spot lesions caused by orthodontic hypomineralisation: A minimally invasive therapy." *British Dent J.* 231.7 (2021): 387-392.
19. Sundfeld, R., et al. "Removal of enamel stains: clinical and microscopic study." *Rev Bras Odontol.* 47.3 (1990): 29-34.
20. Feeney, R.N., et al. "Enamel thickness in Asian human canines and premolars." *Anthropol Sci.* 118.3 (2010): 191-198.
21. Segura A. "Acid-abrasive enamel reduction for tooth color correction." *American J Dent.* 14.2 (1991): 103-104.

22. Mendes RF, Mondelli J, Freitas Cd. "Avaliação da quantidade de desgaste do esmalte dentário submetido à microabrasão." *Rev Facul Odont Bauru*. 1999;7:6.
23. Paic, M., et al. "Effects of microabrasion on substance loss, surface roughness, and colorimetric changes on enamel in vitro." *Quintessence Int*. 39.6 (2008): 517-522.
24. Gelgor I, Aglarci C, Yasa E. "Results of White Spot Lesion Tratment after Orthodontic Treatmens." *J Dent Oral Biol*. 2.8 (2017): 1057.

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