Original Article

Comparison of the Effects of Two Whitening Toothpastes on Microhardness of the Enamel and a Microhybride Composite Resin: An in Vitro Study

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Abstract:

Introduction: Whitening toothpastes which have been accepted in populations may affect properties of enamel and restorative materials. The aim of this study was to compare the microhardness of human enamel and Z250 microhybrid composite resin after brushing with two whitening toothpastes.

Materials and Methods: In this experimental study of enamel specimens, forty five freshly extracted human incisors were prepared and divided into three groups of control enamel (ClE), Crest enamel (CtE) and Aquafresh enamel (AfE). For composite resin specimens, forty five cylindrical-shaped specimens of light-cured Z250 composite were prepared and divided into three groups of control composite (ClC), Crest composite (CtC) and Aquafresh composite (AfC). The control groups were brushed without toothpaste. Crest and Aquafresh group specimens were brushed with Crest and Aquafresh whitening toothpastes, respectively. Vickers microhardness test was performed for all groups. Data were analyzed by One-way ANOVA and Tukey tests.

Results: Microhardness values of ClE, CtE, AfE, ClC, CtC and AfC groups were 332.99 ± 26.59, 313.99 ± 20.56, 323.57 ± 27.96, 137.1 ± 3.16, 122.95 ± 3.27 and 130.36 ± 4.8, respectively. One-way ANOVA showed no significant differences among three enamel groups but there was significant difference among composite groups ($p<0.01$).

Conclusion: Crest and Aquafresh whitening toothpastes did not affect enamel hardness but reduced the microhardness value of Z-250 composite resin. However, Crest whitening toothpaste decreased the microhardness more than Aquafresh.

Key Words: Enamel; Composite Resin; Microhardness; Whitening Toothpaste; Toothbrushing

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INTRODUCTION

Tooth whitening continues to be a rapidly growing area in esthetic dentistry because tooth color and brightness is so important for patients [1,2].

Dentists apply various treatment methods for this purpose such as microabrasion, macroabrasion and bleaching.

Nowadays, whitening toothpastes are used commonly. The whitening effects of these toothpastes are usually achieved by the incorporation of abrasives and bleaching

components. An ideal toothpaste should remove unwanted surface deposits and stains with minimal influence on the enamel, dentine and restorations [3]. Thus, the effects of such products on properties of enamel and restorative materials are important [4]. Microhardness is one of the important properties of the materials which correlates with strength, proportional limit and wear resistance [5]. Many recent published studies have been conducted not only on the chemical stain removal and abrasive properties of the whitening products but also on their effects on the hardness of enamel, dentin and restorative materials [1,6-11]. In 2006, Joiner showed that whitening toothpastes are more effective in stain removal than non whitening dentifrices [1]; however, in 2007, Terezhalmy et al concluded that there is no significant difference between the efficacies of different whitening toothpastes in terms of removal of extrinsic stain [11]. A few researches have been performed on the effects of whitening toothpastes on both enamel and composite resin stain [12-14]. In 2005, Joiner et al showed that whitening toothpastes make no significant wear on the enamel and dentin [14]. Another study which was performed by Joiner et al showed that there was no significant deference between enamel abrasivity of the whitening toothpaste and a standard silica dentifrice [15]. Zimmerman et al reported that whitening treatments could change the mechanical properties of the enamel [16].

According to our search, there was no study to evaluate the effects of different whitening toothpastes on the microhardness of the enamel as well as composite resin.

The main goal of this study was to assess the effect of two whitening toothpastes on the surface hardness of enamel and a microhybrid composite.

MATERIALS AND METHODS

In this in-vitro experimental study, there were two types of specimens made of enamel and composite. To prepare enamel specimens, 45 freshly extracted human insicors were stored in 1% thymol solution. All teeth were examined under magnification ×20 to ensure there are no microcracks and surface defects. To perform the test, the crowns were cut at the cement-enamel junction (CEJ) using a diamond saw (Microslice 2, Metals Research Ltd., Cambridge, UK) using water coolant. The crowns were sectioned to obtain 9 mm^2 enamel slabs. The enamel slabs were embedded in acrylic mold (GC Pattern Resin, GC Co., Chicago, USA). In order to prevent dehydration of the teeth, the acrylic molds were stored in water during setting. All enamel specimens were randomly divided into three groups (Table 1). For composite specimens cylindrical-shaped molds **(**Plexiglas MC**;** Rohm & Haas**,** Philadelphia**,** Pa**)** with disk-shaped specimen wells (2 mm thickness × 6 mm diameter) were used to make 45 specimens. The material used in this study was a microhybrid composite resin (Z-250, 3M Co., St.Paul, MN, USA) in A2 shade. Initially, the molds were slightly overfilled with the material, covered with a plastic matrix strip (Universal strips; Extra Dental, Istanbul, Turkey) and pressed flat with a glass slab to extrude excess material. The composite resin specimens were light polymerized by Astralis 7 (Vivadent, Liechten stein, Swiss) for 60 seconds to ensure adequate polymerization. Prior to the polymerization of each specimen, the intensity of the light source was fixed at 450 mw/cm2, using a light meter (Apoza, Apoza Enterprise Co. Ltd., Taiwan).

Light was positioned at a distance of 1 mm from each specimen. All enamel specimens were randomly divided into three groups (Table 1). All the specimens were polished by the same operator using medium, fine and superfine discs (Sof-Lex, 3M Co., St.Paul, MN, USA) and a slow-speed handpiece (KaVo Electrotorque, KaVo America, Inc., Lakeside,

Table 1. Group definitions.

Groups		Surface Treatment
Control Groups	Enamel (ClE)	-Only brushed using a soft brush* twice a day (morning and evening) each time 1 minute for 4 weeks without toothpaste.
	Composite resin (ClC)	
Treatment Groups	Enamel (CtE)	-Brushed using a soft brush twice a day (morning and evening) each time 1 minute for 4 weeks with Crest** whitening toothpaste.
	Composite resin (CtC)	
	Enamel (AfE)	-Brushed using a soft brush twice a day (morning and evening) each time 1 minute for 4 weeks with Aquafresh*** whitening toothpaste.
	Composite resin (AfC)	

*Gillette Group UK Ltd, London, TW75NP, Ireland
**GlaxoSmithKline group of companies, Brentford, Tw89GS, England #306C
***Procter & Gamble UK, Weybridge, KT13OXP, Germany #6036028831

IL) rotating in one direction. Following each application, specimens were rinsed under running water spray.

Five strokes were made with each disk (medium, fine, superfine) in a sequence.

The polished specimens were cleaned in distilled water in an ultrasonic cleaner (Sonica, Soltec S.i.l. Co., Milano, Italy) for 2 minutes to remove any surface debris. All specimens were then placed in 37^0C distilled water for 24 hours and then brushed (Table 1).

The components of the tested toothpastes are explained in Table 2. Vickers hardness test was performed for all the specimens and values were recorded with a microhardness tester (Micrometer 1, Buehler, Lake Bluff, IL, USA) using a 300 gram load and a 15 second dwell time at room temperature.

Data were analyzed by One-way ANOVA and Tukey tests using SPSS version 13 at the significance level of $\alpha = 0.05$. mean values, ranges, and standard deviations were calculated for the different variables. Statistical analysis was carried out using SPSS 11.0, software.

Chi-square test, ANOVA, multi-variant ordinal regression, and Spearman correlation coefficience were employed for data analysis.

Mean and standard deviations were calculated for crestal bone loss measured after at least 2 years of implant insertion.

RESULTS

The mean microhardness values, standard deviations for composite resin and enamel groups are given in Table 3.

One-way ANOVA showed statistically significant differences among three composite resin groups ($p<0.001$), but there were no significant differences among the three enamel groups ($p=0.132$). Tukey's test showed that there were significant differences between each of the two composite resin groups ($p< 0.05$).

DISCUSSION

It is known that whitening dentifrices used with tooth brushing act to decrease plaque and surface deposits on teeth as well as helping in removing stains and discolorations [13]. Many commercially available ones contain ingredients that may have adverse effects on the surface of restorations and teeth [17]. Little information was available about the adverse effects of some of these new dentifrices [3].

Hardness is a surface property of a material that shows its resistance against permanent deformation. Vickers hardness is a type of microhardness test which is commonly used to evaluate surface microhardness of brittle and restorative materials [5-18].

The composite resin Filtek Z250 as a hybrid composite which is applicable in anterior and posterior restoration was used in this study. variables considering different implant length.

This composite resin has good mechanical properties as well as hardness [19]. In order to achieve an adequate polymerization, resin composite of A2 shade were cured for 60 seconds [20].

In the present study, two whitening toothpastes were used to evaluate their influence on the surface hardness of enamel and composite resin. To minimize the possible effects of tooth brush on surface hardness of enamel and resin composite, soft tooth brushes were used in the current study [5].

The results of this study showed that significant difference in hardness was observed between composite control groups (ClC) and composite treatment groups (CtC and AfC). This finding similar to the results of studies performed by Garci et al [21] and Wang et al [22] suggests that ingredients of the toothpastes used in the present study including a range of components such as sodium bicarbonate, hydrated silica, sodium tripolyphosphate and other ingredients which have the ability to influence substratum surfaces, could affect the surface characteristics of composite materials.

Comparison of the two composite treatment groups (CtC and AfC) indicated that the hardness of composite resins exposed to Crest toothpaste (CtC) decreased more than the hardness of those treated with Aquafresh

Table 2. Descriptive statistics of the measured

Toothpaste	Component
Aquafresh whitening	Sodium tripolyphosphate, sodium hydroxide, flavor, glycerin, silica, PEG-8, sodium benzoate, sodium lauryl sulfate, sodium saccharin, sorbitol, titanium dioxide, water, xanthan gum.
Crest whitening	Hydrated silica, 0.15% sodium fluoride, glycerin, water, sorbitol, sodium hexaameta phosphate, propylene glycol, flavor, PEG-12, cacomidopropyl, sodium lauryl sulfate, carbomer 956, poloxamer 407, polyethyleno oxide, titanium dioxide, xanthan gum, sodium hydroxide, celluse gum, mica.

toothpaste (AfC) and this decrease was statistically significant. This difference may be related to the effective materials and their mechanism of action.

The whitening ingredients in Crest toothpaste are special silica abrasives that prevent formation of stains and remove stains from the surface. However, the whitening ingredient in Aquafresh is sodium tripolyphosphate, a surfactant and chelator, which is effective against calcified stain [3,7]. Moreover, other factors such as particle size and shape, source and purity can affect agent abrasivity [23].

The pH of these toothpastes was 7.62 for Crest and 9.73 for Aquafresh whitening toothpastes. A profilometric study revealed that dentifrices with a basic pH between 7.56 and 8.19 yielded enamel abrasion significantly lower compared with those with a neutral or acidic pH [24]. While, the microhardness values that were obtained in our study were a result of complex factors and their alteration by pH could not be distinguished. In addition, the results showed no significant differences between enamel groups. Because of high hardness of the enamel, different ingredients of these (Table 2).

On the other hand, because the pH of the whitening toothpastes used in the present study were in the reported range of previous studies and were not acidic (pH>7), they could not demineralize the enamel surface and decrease its hardness [25].

Minimal or non-significant reduction of enamel microhardness detected in our study may be related to safety abrasiveness of the studied toothpastes which are produced under the regulatory situation in the EU [26].

Since the whitening gradient of the tested toothpastes in the present study is different from whitening gels, consequently, applied whitening toothpastes are not compared with other used products in researches.

Our results concur Taher's study indicating a significant reduction of surface hardness values of composite resin after using bleaching agents [7].

These results do conflict with Nathoo et al's study, which reported no effect of a professional tooth whitening system on the microhardness of composite resins [27].

This can be attributed to the kind of applied products and difference in the study methods.

As solubility parameters of toothpastes were not measured in this study, evaluating this option was impossible. Future researches are recommended to compare the effect of various whitening toothpastes on others properties of composite resin materials and hard tissues of the teeth.

Table 3. Mean, standard deviation (SD) and standard error (SE) of microhardness values in composite resin and enamel groups

Groups	N	Mean(SD)	SE
ClC	*15*	*137.1 (3.16)*	*.81*
CtC	*15*	*122.95 (3.27)*	*.84*
AfC	*15*	*130.36 (4.80)*	*1.24*
ClE	*15*	*332.99 (26.59)*	*6.86*
CtE	*15*	*313.99 (20.56)*	*5.31*
AfE	*15*	*323.57 (27.96)*	*7.21*

CONCLUSIONS

This in-vitro study demonstrates that use of whitening toothpastes does not affect enamel hardness, but decreases the surface hardness of Z-250 microhybrid composite resin.

Crest whitening toothpaste caused the greatest effect on microhardness of this material**.**

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