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Have an effect different bleaching procedures on esthetic ceramic surface's roughness

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Abstract
Purpose: The purpose of this study was to evaluate the surface roughness of 3 different porcelain systems when applied home bleaching and office bleaching agents.
Materials and Methods: Seventy two disc shaped were fabricated, with a diameter of 12 mm and a thickness of 2 mm from each porcelain material group1; ultra low fucing porcelain (Finesse), group 2; Lithium-disilicate based all-porcelain (IPS E-Max Press), and group3; zirconia (Zirkonzahn Prettau). The specimens were randomly further divided into two groups of 36 to evaluate the effect of 2 bleaching agents%10 Opalescence treswhite supreme gel for group a and%38 Opalescence boost gel for group b. Bleaching agents were applied to porcelain surface according to manufacturer's instructions. For surface roughness measurement a profilometer was used. The data were analyzed by one way ANOVA and paired t test (p<.05).
Results: Bleaching agents did not significantly affect the surface roughness of the group 2 and group 3 however, they significantly increased the roughness of the group 1.
Conclusions: Bleaching agents may affect the roughness of ultra low fucing restorations. Bleaching agents should not be applied to restorations (especially low fucing restorations) due to the high risk of causing surface roughness.

Keywords: bleaching; surface roughness; porcelain

1. Introduction
Discoloured teeth can result in considerable cosmetic impairement. Besides invasive therapies, such as crowning or the placement of veneers, the bleaching of teeth is an alternative therapeutic method. In contrast to crowning or veneering, whitening of teeth is relatively non invasive and conserves dental hard tissue [1]. Tooth bleaching has become popular in dentistry since it has been shown to be an effective and non invasive treatment. The procedure may be performed at a dental office, or the patient may perform the treatment at home by employing a custom-made tooth tray with the agent in gel form and applying the tray to the teeth [2, 3]. Treatment times for home bleaching vary extensively and depend on how much time per day the patient spends employing the suggested technique [4]. On the other hand, office bleaching uses higher concentration solutions applied for shorter periods of time, since these products are capable of producing more peroxide radicals and hence accelerating the process [5]. Many bleaching systems are available but those with proven efficacy share the common mechanism of peroxide. The form of the peroxide (hydrogen peroxide, carbamide peroxide, sodium percarbonate) and the method of delivery (gels in trays, strips, films, or paint-on gels) vary but all have been shown to be efficacious [6]. New home and office bleaching agents also continue to enter the market, and they vary with respect to peroxide concentration, delivery method, contact time, product formulation, and other factors, all of which have the potential to impact the individual's overall clinical tolerability and individual oral response [7, 8]. However, patients need to be informed of bleaching's potential effects on the structure and color of enamel and restorative materials.
New aesthetic materials have been introduced almost daily, yet porcelain remains the material of choice for most clinicians. The preference for porcelain restorations arises from its excellent biocompatibility, the strength and surface texture of the material and their over all esthetic

properties [9]. One of the most important physical properties of porcelain restorations is surface roughness, is described as the overall roughness of a surface. The roughness of intraoral hard surfaces enhances initial adhesion and retention of oral microorganisms and accelerates maturation of plaque through increasing the area available for adhesion. A rough surface may as well abrade opposing tooth or restorative materials [10, 11]. Thus for optimum esthetics, the surface of dental restorations should be as smooth as possible [12]. Numerous studies have shown bleaching to be effective in whitening certain types of discolored teeth [13, 14]. but its effect on enamel and restorative materials is not clearly understood.

The purpose of this study was to determine the surface roughness of 3 different porcelain systems (ultra low fucing, lithium-disilicate based, zirconia) as a result of simulated home bleaching and office bleaching with 10% HP and 38% HP invitro. The null hypothesis was that both bleaching systems would not have meaningful effects on the surface roughness of porcelain systems.

2. Materials and Methods

Seventy two disc shaped were fabricated, with a diameter of 12 mm and a thickness of 2 mm from each porcelain material Group1; Ultra low fucing porcelain (Finesse), group 2; Lithium-disilicate based all porcelain (IPS E-Max Press), group3; Zirconia (Zirkonzahn Prettau). The specimens were randomly further divided into two groups of 36 to evaluate the effect of 2 bleaching agents% 10 Opalescence treswhite supreme gel, for group a,% 38 Opalescence boost gel, for group b (Table 1).

Group 1; Finesse was selected for the fabrication of feldspatic ceramic discs. A mold was made using vinyl polysiloxane putty (Virtual, vynilpolisiloksan, Ivoclar, Schaan, Liechtenstein) to facilitate the fabrication of the porcelain discs (12 mm diameter, 2 mm thick). The porcelain was mixed with sculpting liquid and condensed in to the mold. Tissue (Selpak, Eczacibasi Holding, Istanbul, Turkey) was used to absorb the excess moisture. After drying, the discs were carefully removed from the mold, placed on a saggertray, and fired according to the manufacturers' recommendations (760 ºC) in a porcelain oven (Vita Zahnfabrik H Rauter GmbH & Co. KG, Bad Sackigen Germany). The specimens were then trimmed with a thin cylindrical diamond bur (D-Z Labor; Drendel and Zweiling GmbH & Co, Berlin, Germany). All the ceramic specimen's surfaces were then polished with a special polishing kit (Optrafine, Ivoclar, Schaan, Liechtenstein) that had a slow speed hand piece (NSK, Nissei Bldg., 1-6-3 Ohsaki, Shinagawa-Ku, Tokyo, 141-8560, Japan) running at 15,000 rpm.

Group 2; Empress E-Max specimen (12 mm in diameter and 2 mm in thickness) were waxed (BEGO, Wilhelm–Herbest–Strabe 1 D–28359 Bremen, Germany), sprued, and then pressed after investment. All procedures were performed on Empress E-Max materials (Ivoclar, Schaan, Liechtenstein) according to the manufacturer's recommendations.

Group 3; Zirkonzahn Prettau a mold was made using vinyl polysiloxane putty (Virtual, vynilpolisiloksan, Ivoclar, Schaan, Liechtenstein) to facilitate the fabrication of the porcelain discs (12 mm diameter, 2 mm thick). The zirconia specimens were then produced according to the manufacturer's manual.

After the finishing procedures, specimens were subjected to ultrasonic treatment (Biosonic UC 50, Coltene Whaledent, Cuyahoga Falls, OH, USA) in distilled water to remove any surface residues. They were then dried. All specimens were stored in distilled water in screw top vials (Isolab, Laborgerate GmbH, and Wertheim, Germany) at room temperature for 24 hours before any test procedure.

For group a; the bleaching agent (%10 Opalescence treswhite supreme gel) was performed over a period of 10 days. The specimens were immersed for one hour per day, in accordance with the manufacturer's directions.

For group b; the bleaching agent (%38 Opalescence BOOST gel) was performed 20 minutes. For optimum effectiveness the gel was agiteted every 5 minutes, in accordance with the manufacturer's directions.

Before and after bleaching procudures, the surface roughness of every specimen was measured with a profilometer (Surftest Analyzer 402, Mitutoyo Corporation, Kawasaki, Kanagawa, 213-8533 Japan). The marks delineating the polished side from the auto -glazed side were used to orient the disc on the table of the surface profilometer. The roughness of each side of the disc was analyzed by performing 2 passes of the profilometer, with one pass at a 90- degree angle to the other. The mean Ra of these 2 readings was used for the statistical analysis. The profilometer was calibrated using a standard reference specimen, then set to travel at a speed of 0.100 mm /s with a range of 600 mm during testing and an amplitude transmittance set at 50%. Baseline surface measurements were made before the first application and repeated after the final treatment. The Ra value is derived as the arithmetic mean of the departure from the mean line of the reading. The initial and final Ra mean values for each of the tested specimens were recorded and tabulated. The mean Ra values for each group were recorded, tabulated, and statistically analyzed. The Ra value describes the overall roughness of a surface and is defined as the arithmetic mean value of all absolute distances of the roughness profiles from the center line within a measuring distance.

One-way analysis of variance was used to evaluate the surface roughness measurements. To compare the effects of bleaching agents on surface roughness change in each material, independent samples t-test was performed. The statistically meaningful level was accepted as $p<.05$.

3. Results & Discussion

Values of mean surface roughness and standard deviations for each combination of bleaching and porcelain systems groups are given in Fig.1. According to the measures samples t-test, the effect of bleaching for group a and group b on the surface roughness of group 1 (P =.035, P=.038) was statistically significant. According to the measures samples t-test, the effect of bleaching for group a and group b on the surface roughness of group 2 (P=.084, P=.553), group 3 (P=.184, P=.134) was not statistically significant (Table 2).

Based on the results, the null hypotheses that both bleaching systems would not have meaningful effects on the surface roughness change of porcelain systems, was rejected.

Interaction between bleaching agents and oral structures is of critical importance, and some chemical aspects involved in bleaching could negatively interfere with this [15, 16].

Several studies have investigated the effects of bleaching agents on the surface characteristics of restorative materials. Surface roughness of a restoration is important, as it plays a major role in the formation of biofilms and bacterial adhesion that may lead to gingival inflammation and caries [17]. Surface phenomena, such as increased porosity or decreased hardness, are reported as a result of deleterious impact on teeth or fillings. Surface roughness is a clinically important property

that warrants investigation, since it can influence both aesthetics and health [18, 20].

This *in vitro* study measured the surface roughness changes of 3 different porcelain systems as a result of simulated office bleaching and home bleaching with 38% HP and 10% HP *in vitro*. The results of this study do not support the hypothesis that the different bleaching systems made different surface changes on porcelain systems.

Numerous studies conducted *in vitro* have reported that the enamel surface can be affected by highly concentrated bleaching agents or by the repeated application of home agents [19, 3]. and alterations of histological and composition aspects have been described [21, 22]. Also, bleaching agents might enlarge gaps between enamel prisms, resulting in invasive pathways to the surface [23].

In most studies there is found to be no significant increase in composite surface roughness after exposure to home bleaching [21, 24, 25]. In other studies [5, 26]. the authors reported roughening and cracking of resin composite after the SEM evaluation.

Hydroflouric acid is known to be an etchant of feldspathic ceramics as it causes dissolution of glass-matrix-creating micro-irregularities. It is used as a treatment to enhance resin adhesion. In addition, in their study on the effect of bleaching on ceramics, Türker and Biskin [24, 27]. revealed a reduction in the feldspathic porcelain surface SiO_2 content of between 4.82% and 4.44%, which probably contributed to the increased roughness detected. The investigations on the effect of bleaching agents on ceramic restorative materials were performed by Turker and Biskin [20, 27]. who evaluated the effects of bleaching agents on feldspathic porcelain. They observed that 10–16% carbamide peroxide gels (applied for 8 h per day for 30 days) were able to significantly decrease surface hardness of the porcelain material tested. However, surface texture was not effected by the bleaching regimen, as also reported in an SEM investigation by Schemehorn *et al*, [28]. when applying a 6% hydrogen peroxide gel on feldspathic porcelain.

The Finesse exhibited changes in surface roughness after bleaching agents. In the present study, the two bleaching agents caused more surface roughness in the Finesse than other porcelain systems. The reason for this result can be correlated with its more glassy phase.

Another finding from the present study is that IPS E-max porcelain materials shaped under pressure and heat treatment that nevertheless display changes in surface to differing extents in the face of bleaching agents. The reason for this is thought to be resulted from the fact that the two materials have differing crystal structures (crystal sizes and rates).

Zirkonzahn prettau had been found to show no surface roughness changes related with its noncrystalline phase structure.

A study has reported that the bleaching process applied to the vital teeth had no effects on color change or other physical properties of porcelain systems. White *et al*,[29]. Rosen-tritt *et al* [30]. De A Silva *et al* [6]. and Moraes *et al* [2]. Duschner *et al* [31]. reported no changes in surface morphology of porcelain exposed to bleaching. This could have been due to the lower concentration of the bleaching agents used in their study.

There are some limitations of the current study design that must be noted. As in many *in vitro* studies, the oral environment cannot be fully simulated. One of the limitations of the *in vitro* studies is the lack of saliva. Many of the products are left in contact with the restorative materials for 8 h without the dilution, or activation, effects of saliva. In clinical applications of bleaching agents, even with tray based systems, the concentration of hydrogen peroxide has been shown to reduce dramatically due to the effects of saliva.

Not withstanding, further studies are required in order to evaluate the safety of bleaching processes and their effects on porcelain systems.

3.1 Tables and Figures

Table 1: Tested materials

Materials	Product Name	Manufacturer	Batch numbers
Lithium-disilicate based all-porcelain	IPS Empress e- Max press	Ivoclar Vivadent AG, Schaan, Liechtenstein	L36215
Ultra low fucing porcelain (760º C)	Finesse	Ceramco Inc. Burlington, NJ, USA.	291106
Zirconia based all porcelain	Zirkonzahn Prettau	Zirkonzahn GmBh,Bruneck,Italy	ZA9247E
Bleaching agent	Opalescence treswhite (%10)	Ultradent, South Jordan,Utah, USA	115346
Bleaching agent	Opalescence BOOST (%38)	Ultradent, SouthJordan,Utah, USA	R5SR3

Table 2: Paired Samples Test

ab – bb Pair 1 Groups	1a	1b	2a	2b	3a	3b
Sig. (2-tailed)	, 035	, 038	, 084	, 553	,184	,134

ab= after bleaching bb= before bleaching

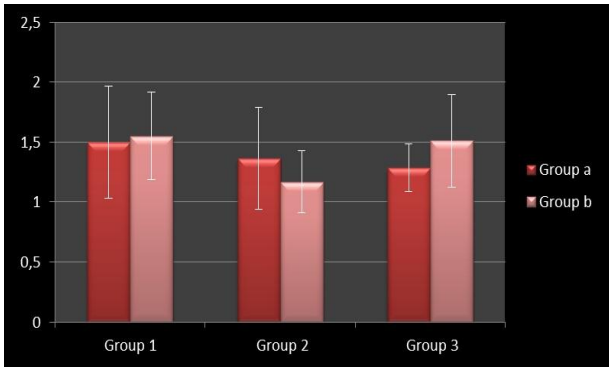

Fig 1: Surface roughness values for groups

4. Conclusions

Considering the experimental limitations of this *in vitro* study bleaching agents were more likely to cause surface roughness change of Finesse compared with IPS E-Max and Zirkonzahn Prettau because of its glassy phase. Although direct clinical effects depend on the actual *in vivo* conditions, bleaching procedures should not be carried out indiscriminately when restorations are present.

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