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Effect of different bleaching agents on the surface roughness and color stability of feldspathic porcelain

Efeito de diferentes agentes de clareamento na rugosidade superficial e estabilidade de cor da porcelana feldspática

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ABSTRACT

Objective: The aim of this study was to evaluate the effect of different bleaching agents on the surface roughness and color stability of feldspathic porcelain. **Material and Methods:** In this study, totally 40 disc-shaped Noritake and Ceramco 3 feldspathic porcelain and two bleaching agents (Opalescence Boost and Opalescence Pf) were used. Bleaching agents were exposed to specimens according to their protocol. Then, the surface roughness of the specimens was evaluated with profilometer and the color of the specimens was recorded by colorimeter. Statistical analysis of the data was performed with IBM SPSS Statistics 20. **Results:** The results showed that that there were statistically significant differences between the bleaching agents on the surface roughness of feldspathic porcelain ($p<0.05$). However, there were no statistically significant differences between the bleaching agents on the color stability of feldspathic porcelain ($p>0.05$). **Conclusion:** The obtained data presented that the bleaching agents increased the surface roughness and not affect the color stability of the feldspathic porcelain.

KEYWORDS

Bleaching; Ceramic; Color; Surface roughness.

RESUMO

Objetivo: O objetivo deste estudo foi avaliar o efeito de diferentes agentes clareadores sobre a rugosidade superficial e estabilidade de cor da porcelana feldspática. **Material e Métodos:** Neste estudo, foram utilizados 40 porcelanas feldspáticas Noritake e Ceramco 3, em forma de disco, e dois agentes clareadores (Opalescence Boost e Opalescence Pf). Os agentes clareadores foram expostos às amostras de acordo com seu protocolo. Em seguida, a rugosidade superficial dos corpos de prova foi avaliada com perfilômetro e a cor dos corpos de prova foi registrada por colorímetro. A análise estatística dos dados foi realizada com o IBM SPSS Statistics 20. **Resultados:** Os resultados mostraram que houveram diferenças estatisticamente significantes entre os agentes clareadores na rugosidade superficial da porcelana feldspática ($p<0,05$). No entanto, não houve diferenças estatisticamente significativas entre os agentes clareadores sobre a estabilidade de cor da porcelana feldspática ($p> 0,05$). **Conclusão:** Os dados obtidos mostraram que os agentes clareadores aumentaram a rugosidade superficial e não afetaram a estabilidade de cor da porcelana feldspática.

PALAVRAS-CHAVE

Clareamente; Cerâmica; Cor; Rigidez da superfície.

INTRODUCTION

There have recently been changes in esthetical points of view and expectations for improving and developing esthetic treatments in the field of dentistry. Whiter teeth have become the biggest esthetic concern over the past few years and worldwide, most people want non discolored and esthetically appealing teeth [1].

Several approaches, including whitening toothpastes, can improve tooth color. Other approaches include professional cleaning by scaling and polishing to remove stain and tartar, tooth bleaching, micro abrasion of enamel with abrasives and acid, and the placement of crowns and veneers [2,3]. Bleaching is one of the most commonly used clinical dental esthetic procedures [4]. Bleaching is used to increase the brightness of teeth, but it may also affect the surface of restorative materials [5,6].

Bleaching was first used for discolored teeth in the 1870s [7]. Bleaching techniques may be classified for teeth that are either vital or non-vital. Moreover, bleaching procedures can be performed using either in-office or at-home methods [8-10]. Bleaching agents usually contain some form of peroxides (generally carbamide peroxide [CP] or hydrogen peroxide [HP]) in a gel or liquid form that makes contact with the teeth for several minutes to several hours depending on the formulation of the material used [2,10-13]. CP is used for at-home bleaching, while higher concentrations of hydrogen peroxide, up to 35%, are recommended for in-office bleaching and non-vital bleaching. For at-home bleaching, CP at a 10% concentration is usually used [6,14,15].

The reaction of CP with the teeth releases hydrogen peroxide and free radicals, which are responsible for dental bleaching [16,17]. Despite the wide approval of at home bleaching techniques, the use of peroxides may lead to clinical side effects due to the reactive nature of hydrogen peroxide, so patients may experience dentin sensitivity and/or gingival irritation [16-20]. Depending on the bleaching agent used, properties of restorative materials can be altered and lead to corrosion and other changes. Thus, the life cycle of the prosthesis and restorative material may be shortened.

The aim of this study was to evaluate the effect of different bleaching agents on the surface roughness and color stability of feldspathic porcelain. The hypothesis of this study was that bleaching agents would not significantly affect the roughness or color stability of feldspathic porcelain.

MATERIAL AND METHODS

In this study, 40 disc-shaped, 2-mm thick, 10-mm diameter specimens with a shade of A1 were used. The specimens were one of two types of feldspathic porcelains, Ceramco 3 (Dentsply, Burlington, New Jersey, USA) or Noritake (Noritake Dental Supply Co. Ltd., Nagoya, Japan).

First, wax casts of the specimens were prepared for the porcelain specimens. The wax casts were then immersed in an elastomeric impression material (Optosil; Heraeus Kulzer, Hanau, Germany). The wax casts were taken out after the impression material had hardened, then the impression molds were prepared for using porcelain specimens. After the isolation, dentin and enamel porcelain specimens were used in the molds and then vibrated, dried, and fired. After the preparation of the porcelain specimens, they were ground with a diamond bur (Blaudent, Tallinn, Estonia). Finally, the all specimens were glazed over (Ivoclar Vivadent AG, FL-9494 Schaan, Liechtenstein) and stored in distilled water for 24 hours.

Two bleaching agents were used in this study: Opalescence Boost (Ultradent Products Inc., South Jordan, Utah, USA) for in-office bleaching and Opalescence Pf (Ultradent Products Inc., South Jordan, Utah, USA) for at-home bleaching. Opalescence Boost contains 40% hydrogen peroxide and Opalescence Pf contains 16% CP. The specimens were randomly divided into two groups according to the bleaching agents.

Bleaching procedure

Bleaching procedures were performed at 37°C for 7 days [21,22]. Ten specimens per group were exposed to a 16% CP agent for 6 hours daily. Hydrogen peroxide was applied to completely cover the other specimens' surfaces for 30 minutes. During session intervals of bleaching exposure, the specimens were washed under running distilled water for 1 minute and then placed in fresh distilled water at 37°C until use.

Roughness test

The specimens were positioned so that their surfaces were in contact with the diamond tip of the profilometer (Surtronic 25; Taylor Hobson, Leicester, U.K.). The baseline data for surface roughness were recorded by the profilometer, which was calibrated with a cutoff value (λc) of 0.80mm, an evaluation length of 2.4mm before the bleaching procedure. Each specimen was measured twice and the average baseline roughness (Ra) values were determined. After the bleaching treatment, the final surface roughness was recorded by the profilometer with the same parameters.

Color test

Before the bleaching treatment, the specimens were rinsed under tap water for one minute and blotted dry. The color value of each specimen was then recorded with a colorimeter (Shade Eye NCC; Shofu Dental Corporation, Kyoto, Japan). The specimens were positioned so that their surfaces were in contact with the aperture head of the colorimeter. Each specimen was measured twice and the average baseline values for L*, a*, and b* were calculated. After bleaching, the final color measurements were recorded using the colorimeter with the same parameters. The magnitude of the total color difference (ΔE*) was calculated using the following equation [23]:

$$\Delta E^* = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$$

where ΔL*, Δa*, and Δb* are changes in L*, a*, and b* after bleaching, respectively.

Statistical analyses of the data were performed with independent samples t-tests using the IBM SPSS Statistics 20 program.

RESULTS

The results of the Student's t-tests showed statistically significant differences on the surface roughness of feldspathic porcelain after bleaching ($p<0.05$) and not between the bleaching agents ($p>0.05$).

The results of the paired-samples tests showed that at-home and in-office bleaching methods were statistically significant in Ceramco 3 porcelains ($p<0.05$). At-home bleaching was statistically significant in Noritake porcelains ($p<0.05$), while in-office bleaching increased the surface roughness of porcelains, but it was not statistically significant in Noritake porcelains ($p>0.05$) (Table 1).

The results of the independent samples tests showed that there were no statistically significant differences between the bleaching agents on the color stability of feldspathic porcelain ($p>0.05$).

There were statistically significant differences between at-home and in-office bleaching agents in the Noritake group ($p<0.05$), with the at-home bleaching values being higher. The in-office bleaching had more of an effect on Ceramco 3 porcelains. The effect of at-home bleaching was similar in both groups and there were no statistically significant differences ($p>0.05$) (Table 2).

Table 1 - The result of surface roughness

Porcelain	Bleaching Agent	N	Mean	Std. Deviation	Sig.
Ceramco 3	Home	10	-.54	.65	.03
	Office	10	-.44	.49	.02
Noritake	Home	10	-.48	.50	.01
	Office	10	-.28	.47	.09

$p<0.05$.

Table 2 - The result of colour changes

Porcelain	Bleaching Agent	N	Mean	Std. Deviation	Sig.
Ceramco 3	Home	10	5.29	1.87	.6
	Office	10	5.75	2.06	
Noritake	Home	10	5.23	2.03	.04
	Office	10	3.56	1.23	

$p<0.05$.

DISCUSSION

The hypothesis set as the premise of this study was not accepted because the bleaching agents affected the surface roughness of the feldspathic porcelain. However, the other hypothesis set as the premise of this study was accepted. Namely, the bleaching agents did not affect the color stability of the feldspathic porcelain.

Feldspathic porcelain is the most preferred type of ceramic in metal-ceramic restorations. In addition, it is the most preferred porcelain system in our clinics. The economic and reparability of these porcelains is another reason to prefer their use. For these reasons, feldspathic porcelain was preferred in this study.

People's esthetic expectations have been increasing recently. For this reason, in dentistry, esthetic materials and treatments are becoming increasingly popular and widespread. Bleaching is just one of these treatments.

Fixed prosthetics are difficult to remove from the mouth after cementation, and they may undergo some changes in the mouth due to daily use. These changes can include discoloration, loss of surface finish, and cracks in the porcelain. Home bleaching agents are applied to completely arch in the mouth. Bleaching agents can also create changes in the porcelain surface.

Zaki and Fahmy [24] distinguished between auto-glazed and over-glazed ceramic restorations. They showed that an in-office bleaching procedure with 35% CP followed by an at-home bleaching technique with 15% CP significantly increased the surface roughness and changed the whiteness of the polished and over-glazed ceramic restorations but did not affect the auto-glazed ceramic restorations. At-home bleaching and in-office bleaching affected the surface roughness of both over-glazed feldspathic porcelains in the current study. Ourique et al. [20] found that the surface roughness of all evaluated dental ceramics (one fluorapatite glass ceramic and two feldspathic ceramics) were not affected by treatment with 10% or 16% CP over 126 hours. However, applying 16% CP for 6 hours daily for 7 days had a statistically significant effect on the surface roughness of the feldspathic porcelains in this study. We believe that this importance was due to the application of more time to the agents. On the other hand, the efficacy of bleaching on dental ceramics is unknown [5]. Butler et al [25] reported that 10% CP roughened the surface of porcelain. In a recent in vitro study [22], feldspathic porcelain had a rougher surface after 21 days of exposure to 10% and 35% CP. Qasim et al [26] evaluated the effects of two different bleaching agents on the surface roughness properties of dental resin nanocomposites and dental porcelains and reported no remarkable difference between the bleaching agents (Opalescence Boost and Whiteness HP Blue). We believe that this difference in literature may vary depending on the duration of application.

Polydorou et al. [8] showed that the effect of bleaching on the surface texture was material and time dependent. This group used polished ceramic surfaces exposed to 38% hydrogen peroxide for 45 minutes and showed slight changes in surface texture, as evaluated by scanning electron microscopy. However, in the same study, no significant difference was noted when ceramic surfaces were exposed to 15% CP for 56 hours [27]. In the current study, 40% hydrogen peroxide for 30 minutes had a statistically significant effect on the

surface roughness of Ceramco 3 porcelain but had no statistically significant effect on the surface roughness of Noritake porcelain. This difference can be caused by structural and surface differences of both porcelains.

Thickness and light transmission can affect the color of a sample [28]. In response to this finding, previous color studies [29-31] standardized all samples to be 2 mm in thickness. Other studies have prepared the color samples to be either 10 mm in diameter [32,33] or 6 mm in diameter [32], which is suitable for the optical screen of the color measurement device [34]. In this study, a 2 mm thickness and 10-mm diameter were used for all specimens.

Color differences with corresponding ΔE* values lower than 3.3 are acceptable in clinical dentistry [32,35]. In the current study, ΔE* values changed between 0.8 and 8.2, but there were no statistically significant differences.

Yu et al [36] evaluated the effects of bleaching on the mechanical and color properties of seven restorative materials and found that surface roughness increased, and significant color changes were observed for all tested specimens after bleaching treatment, except for the ceramic. Rodrigues et al [37] evaluated shade stability and surface properties of a glazed feldspathic ceramic subjected to bleaching and simulated brushing and found that bleaching agents associated with brushing cycles can alter surface properties and shade stability of glazed feldspathic ceramic. In a clinical study, Haywood and Parker [38] reported that the "night guard vital bleaching" method, which contains 10% CP, had no effect on glazed porcelain and the discoloration that occurs in porcelain restorations not reinforced with metal is related to the change in the color under the tooth's surface. In another study, Zaki and Fahmy [24] reported that a bleaching agent containing 15% CP had numerically little whitening effect on auto-glazed feldspathic porcelain (Duraceram) because it did not bring about any statistically significant color change. Furthermore, in the current study, 16% CP had no effect on the color stability of feldspathic porcelain.

The present study has some limitations. For example, as this study was prepared in vitro, intra-oral factors were not present. Therefore, whether the data can be applied to mechanical and chemical properties in the oral cavity is not fully known. In this study, only the feldspathic porcelain was investigated. Therefore, the effect of bleaching agents on other ceramic systems is unknown.

Within the limitations of this study, it can be concluded that bleaching agents affected the surface roughness of feldspathic porcelain, but the type of bleaching agents did not have a statistically significant effect the surface roughness of feldspathic porcelain. In addition, the bleaching agents did not affect the color stability of feldspathic porcelain, but at-home and in office bleaching affected the color stability according to the type of feldspathic porcelain. At-home bleaching may be considered more effective for Noritake porcelain, while in-office bleaching may be considered for Ceramco 3 porcelain.

If the patient has a fixed prosthesis, at-home bleaching applications can cause roughness of the porcelain surface. Accordingly, healthy and long-term use of porcelain may be restricted.

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Conflict of interest

Authors declare that they have no conflict of interest.

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