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The Effect of Chlorhexidine Mouth Rinse on the Colour Stability of Porcelain with Three Different Surface Treatments: An in Vitro Study

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Abstract

Statement of problem: The effect of mouth washes on discolouration of dental ceramics with different surface preparations is not well documented.
Objectives: This in-vitro study has been conducted to evaluate the effect of chlorhexidine (CHX) mouth rinse on colour stability of overglazed (OP), autoglazed, (AP) or polished porcelain (POP) specimens.
Materials and Methods: The restorative material investigated in this study was overglazed, autoglazed, or polished feldspathic porcelain. A total of 48 cylandrical specimens were prepared, (n=16 per each group). After baseline colour measurements, for a period of14 days 8 specimens of each group were immersed in 15 ml of 0.2% chlorhexidine mouth rinse twice daily for 2 min. After each immersion, the specimens were washed and stored in artificial saliva. Half of the specimens from each group were selected randomly as controls and stored in artificial saliva that was changed daily. The colour change (ΔE) of the specimens was measured by a spectrophotometer device. Data were statistically analyzed using 2-Way ANOVA followed by Tukey test
Results: All the specimens displayed colour changes after immersion in chlorhexidine mouth rinse. POP specimens exhibited more colour change compared to AP and OP specimens (P=0.001). AP and OP specimens showed relatively the same colour change which was not significant compared to the control groups (P=0.9).
Conclusion: Auto-glazed and over-glazed porcelain can tolerate chlorhexidine mouth rinse better than polished porcelain. However the colour changes of the ceramic with three different surface preparations were not perceivable clinically.

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Introduction

Smile appearance is among very important and impressive factors in aesthetics that is affected by several different factors like tooth shape, texture, position, and colour. Attractive teeth have always been the typical patients' primary concern [1-3]. Currently, various types of aesthetic material with different physical characteristics and colours are available [4-6]. One of the most popular dental aesthetic materials is ceramic. Dental ceramics are generally used to restore the teeth because of their excellent aesthetics, wear resistance, chemical inertness, low thermal conductivity, and diffusivity. In addition, they match the characteristics of tooth structure fairly well [7].

Three commonly used surface treatments on ceramic restorations include natural or autoglaze, applied overglaze, or polishing. Porcelain has the ability to glaze itself when held at its fusing temperature under air for 1 to 4 minutes. Applied overglaze is low-fusing clear porcelain that is painted on the surface of the restoration and fired at a fusing temperature much lower than the fusing temperature of the dentine and enamel porcelains [8]. An alternative to glazing is polishing the porcelain surfaces. This provides greater control of the surface luster and distribution than glazing [8,9].

High oral hygiene plays an important role in achieving the long-term therapeutic targets of comfort, good function, treatment predictability and longevity of the fixed and removable prosthesis [10]. Improved understanding of the infectious nature of dental diseases has dramatically increased interest in plaque control by using chemical and holds great promise for advances in disease control and prevention [11].

The chemical agent that has shown the most positive antibacterial results to date is chlorhexidine, a diguanidohexane with pronounced antiseptic properties. Several other clinical investigations confirmed the initial finding that two daily rinses with 10 ml of a 0.2% aqueous solution of chlorhexidine digluconate almost completely inhibited the development of dental plaque, calculus, and gingivitis in the human model for experimental gingivitis [11-13]. Localized, reversible side-effects to chlorhexidine use may occur; these are primarily brown staining of the teeth, tongue, silicate and resin restorations and transient impairment of taste perception [14]. Since the usage of chlorhexidine can cause colour change of aesthetic material [5], it is important to recognize which material is less susceptible to extrinsic staining [13].

Extrinsic factors include staining by adsorption or absorption of colourants from exogenous sources, such as coffee, tea, nicotine, and mouth rinses. Additionally, colour change has been reported to be dependent on the brand and shade of the material, exposure time and intensity and finishing techniques. The reduction in pH of the test solutions had only little effect on colour change [15]. Various finishing and polishing methods have been suggested to produce smooth surfaces, which are theoretically less susceptible to plaque and staining; however, according to Reis et al., the smoothest surfaces were not necessarily the most stain-resistant [16]

Researchers have shown the effect of cholorhexidine and other chromogenic mouth washes on different restorative materials, comparing colour resistance of these materials with each other. Lamba et al. have shown that immersion of composite, glass ionomer cement and compomer in the respective mouth rinses will make significant colour change of these materials [17]. Celik et al. evaluated the effects of 3 mouth rinses including chlorhexidine on 4 different resin-based composite restorative materials, and concluded that although visually non-perceptible, all resin restorative materials tested showed a colour change [18].

Despite the fact that ceramics are the most common material in indirect aesthetic dentistry, there is no published article regarding the effect of staining agents including mouth rinses on colour stability of ceramics. Therefore the aim of this study was to evaluate and compare the influence of chlorhexidine (CHX) mouth wash on colour stability of autoglazed, overglazed or polished feldspathic porcelain.

Materials and Methods

48 specimens were prepared by mixing porcelain powder and liquid of shade A_2, (Duceram Love, DeguDent GmbH, Dentsply, Germany). Then the specimens were formed by condensing body porcelain in prefabricated disc shape metal molds 10 mm in diameter and 2 mm in thickness (Figure 1).

Figure 1: Disc shape specimens with 10 mm in diameter and 2 mm in thickness.

After preparation, all specimens were fired in vacuum furnace in 900º C, and 890º C according to manufacturer's instructions. After air-cooling at room temperature, they were ground flat and wet polished with progressively finer grit aluminum oxide abrasive papers. For surface conditioning phase, the specimens of the porcelain were divided into three groups (n=16). The first group (OP) was overglazed and the second group (AP) was autoglazed according to the manufacturer's instructions. The third group (POP) was polished. The polishing process was done using medium, fine, and superfine Komet (West one Dental, Croydon, UK) disks on a slow-speed hand-piece.

All the specimens were cleaned with 1 min air-water spray and stored in distilled water at 37º C for 24 hours. Then the specimens in each group were numbered from 1 to 16. After that, the baseline colour values (L^*, a^*, b^*) were measured with a spectrophotometer (DeguDent, Dentsply, Germany) against a white background. Quality of colour was examined using the Commission International de I'Eclairage (CIE L^* a^* b^*) system as tristimulus values and reported as colour differences (ΔL^*, Δa^*, and Δb^*) compared with standard conditions. The program of shade pilot Optic Communication System was set, the specimens shade colour was measured, and the spectrophotometer was calibrated with a standard white card. Measurements were repeated 3 times in each specimens and mean values were calculated.

Eight randomly selected disk shape specimens from each group were immersed in artificial saliva (Glandsane, Fresenius Kabi Ltd Co. U.K.) as the control group. For a period of 14 days, the other twenty-four specimens were immersed twice daily in 15 ml of the 0.2% chlorhexdine mouth rinse (Shahrdarou Co. Tehran, Iran) for 2 min under constant agitation using an ultrasonic device. Following immersion in the mouth rinse, the specimens were washed with distilled water and stored in artificial saliva. They were kept at 37^{o}C throughout the study.

After the immersion period, the colour values of each specimen were remeasured, and the colour change value (ΔE) $L^{*}a^{*}b^{*}$ was calculated according to the following formula [4, 16].

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

Where L* stands for lightness, a* for green-red (-a=green; +a=red) and b* for blue-yellow (-b=blue; +b=yellow).

Data were analyzed using SPSS version 16.00 Statistical analyses were performed using 2-way ANOVA and Tukey's HSD test at the significance level of 0.05.

Results

Figure 2 presents the mean of (ΔE) in 3 porcelain groups after immersion in CHX mouth rinse as treatment and artificial saliva as control.

The 2-way Analysis of Variance (Table 1) showed that either the surface or the solution has statistically significant impacts on the amount of ΔE.

However, the interaction of the surface* solution was not statistically significant (P=0.227). For paired comparison of materials, Tukey's HSD-test was used. By this test, it was revealed that ΔE of POP group significantly differ from ΔE of the other groups (OP and AP) (P=0.001), while no significant differences was observed between the AP and OP groups.

Between ΔE of OP and AP immersed in CHX and artificial saliva, there were no significant differences (P=0.9), but in POP between ΔE of specimens immersed in CHX and saliva there were significant differences (P<0.05). Therefore we can conclude that although all specimens displayed colour changes after immersion in solution, POP specimens exhibited more colour change. Colour changes of AP and OP groups were relatively the same and they were not statistically significant compared to the control groups (P>0.05).

Discussion

Due to increasing demand, aesthetic restorative materials have drawn extensive attention, and have been the topic of interest for the majority of dental research, but these may be adversely affected by the continuous and prolonged use of mouth rinses [1-4]. Since the usage of mouth rinses could cause discolouration of restorative materials, the

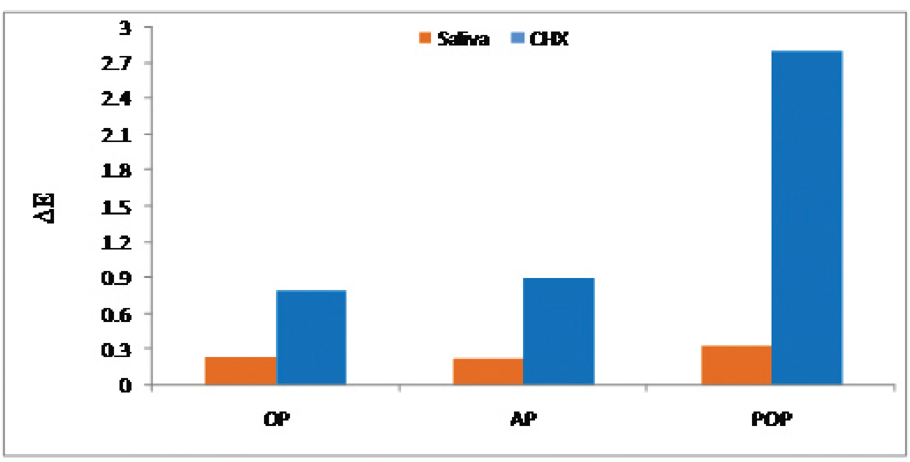

Figure 2: Mean of colour change values (ΔE) in porcelain groups immersed in saliva as control and CHX as treated solution. OP=Overglazed Porcelain; AP=Autoglazed Porcelain; POP=Polished Porcelain; CHX=Chlorhexidine

Table 1: Two way analysis of variance for comparison of colour change values between porcelain groups immersed in saliva and Chlorhexidine

Source	Sum of Squares	Df	Mean Square	F-value	P value
Surface	29.881	2	14.941	18.722	0.000
Solution	6.170	1	6.170	7.732	0.008
surface*solution	2.456	2	1.228	1.539	0.227
Error	31.122	39	0.798		

susceptibility of these materials to colour change should be examined.

A restoration that undergoes significant discolouration is undesirable for either patient or dentist. Indeed, discolouration is considered a major aesthetic failure in tooth-coloured restorations. However, restorative materials have been reported to change colour because of intrinsic and extrinsic factors. Intrinsic factors involve chemical changes of the material. The cause of such chemical discolouration has been attributed to oxidation of the amine accelerator, exposure to various energy sources, and immersion in water for a long period. Extrinsic factors include staining by adhesion or penetration of colourants, a result of contamination from exogenous sources such as coffee, tea, other stain-producing beverages and solutions [19].

Discolouration can be evaluated with different instruments and techniques. In this study, digital analysis of colour changes was done with a spectrophotometer after immersion in chlorhexidine mouth rinses due to discrepancies in views about the colour matching with human eye evaluation versus various more sophisticated modes available [20]. Colour can be measured in dentistry using a tristimulus colour analyzer that measures reflective colours of surfaces. It was demonstrated that colour measurement using a colourimeter provides consistent colour evaluation [20,21]. Colourimeter uses the CIE L^* a^* b^* colour system, which is a method developed in 1978 by the Commmission Internationale de I'Eclairage for characterizing colour based on human perception [22, 23]. L* coordinates are located along a vertical axis that ranges from a value of 0 (blackest) to 100 (whitest). a* and b* coordinates revolve on axes around L*. Coordinate a* measures red at the positive value and green at the negative value, similarly, coordinate b* measures yellow at the positive value and blue at the negative value. Absolute measurements can be made in L* a* b* coordinates and colour change calculated as ΔE (L* a* b*). A ΔE value of 3.7 or less is considered to be clinically acceptable [23-25].

The present study evaluated the effects of a commercially available mouth rinse (chlorhexidine) on the colour stability of three different surface treatments of porcelain. The routine doses of chlorhexidine are 0.12% and 0.2%. One study revealed equal efficacy for 0.2% and 0.12% rinses when used at appropriate similar doses [26]. Furthermore only the 0.2% form is available in Iran. According to the results of the current study, daily use of mouth rinses increased the staining ability of the autoglazed, overglazed and the polished porcelains. The colour change of polished specimens was more noticeable whereas the glazed specimen sustained less influence. The colour differences of the ceramic with 3 different surface preparations were within clinically acceptable limits ($\Delta E<3.5$).

An alternative to glazing is to polish the porcelain surfaces of the restoration. This provides greater control of the surface luster and distribution than glazing. In addition to this aesthetic advantage, in laboratory studies polishing has not been found to result in reduced physical properties in comparison with glazing [27].

Traditionally, polished porcelain has been regarded as a rougher surface than glazed porcelain. However, recent qualitative and quantitative evaluations of polished porcelain surfaces indicate that an acceptable surface may be obtained by using a commercially available adjustment kit. It was showed that polished porcelain to be less destructive of tooth structure in the opposing arch than glazed porcelain [28,29].

Proper finishing and polishing of porcelain restorative materials are important steps that enhance both aesthetics and longevity of the restored teeth. Surface roughness associated with improper finishing and polishing can result in increased plaque accumulation, which can compromise the clinical performance of the restoration [8,9].

Previous studies concerning colour stability have shown that drinks and mouth rinses have varying degrees of staining effect on different composite materials. The staining potential of these drinks and solutions vary according to their composition and properties [5,17-19]. Moreover finishing and polishing procedures may influence the quality of the surface and can therefore be related to the early discolouration of the resins [16]. Rutkunas et al [29] reported that surface glazing caused a similar colour change in all tested resins, irrespective of the material type. This was probably because the whole surface was covered with glaze and only the resin matrix reacted with the extrinsic factors. With surface glazing, the surface coating material – in addition to the benefits of the polishing procedure- augmented the staining resistance by reducing the porosity of the surface. On the other hand, according to Lambrechts and Vanherle [30], glazing material was lost over time from the superficial pores that acted as retentive cavities; therefore, the improved resistance to staining might be of only temporary benefit. The major goal of glazing is to produce a smooth surface; although surface smoothness contributes to colour stability, a positive correlation between the surface roughness and staining is not always present [31].

However, in dental literature, only a few studies have been reported on the colour stability of porcelain [20-22]. Kokosal and Dikbas [32] showed that porcelain denture teeth were more colour stable than acrylic denture teeth against coffee, tea and coke. However, no investigation has been done on the effect of different types of ceramics, finishing, polishing techniques and colourants on discolouration of porcelain materials. These backdrops of information prompted the researcher to conduct this in vitro study.

Dentists should be aware of the physical properties of some dental restorations. They should also make sure that their patients with dental restorations are aware of the colour changes that may occur after long-term usage of mouth rinses such as chlorhexidine, as well as the possibility that their restorations may need to be polished, reglazed or even replaced in long term. It is important to note that in vivo chemical degradation of restorative surfaces cannot be attributed to a single chemical but it is the result of complex reactions between different chemicals. Thus, there may be negative effects of mouth rinses on the restorative materials as they include different solutions (e.g. water and alcohol). Moreover, variations of temperature, pH and different chemicals could also negatively affect these materials [33, 34].

In this study, it was shown that although visually not perceptible, all ceramics with different surface treatments showed a colour difference after immersion in CHX. Although CHX is the most chromogenic mouth rinse, further research is essential to determine the effect of other mouthwashes on different ceramic materials. Because this is the first study about the discolouration of porcelain by chlorhexidine, effect of other factors such as thermocycling and food staining substances can be considered in the future investigations. However, it seems logical to consider precautionary measures to prevent any side effects until complete safety of all porcelain treatments will be proved.

Conclusion

Within the limitations of this study, it can be concluded that:

1. The type of surface conditioning affects the amenability of porcelain surface from chlorhexidine solution.
2. All the porcelain specimens displayed colour changes after immersion in chlorhexidine. But these changes were not visually perceptible.
3. Polished specimens showed the highest change in colour values followed by autoglazed and over-glazed.

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Conflict of Interest: None declared.

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