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Research Article

The Effect of Chlorhexidine Mouth Rinse on the Color Stability of Porcelain - A Systematic Review

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Abstract

Background: Esthetics is one of the fundamental goals of restorative treatment. Dental ceramics have been used as a restorative material of choice for many decades because of its superior properties to other materials and its ability to mimic natural tooth better. However, these are known to show some discoloration under some fluids and conditions. The present review is conducted to study the color stability of ceramics when exposed to Chlorhexidine gluconate (CHX) mouth rinses.

Materials and Methods: This review was conducted and reported according to the PRISMA guidelines. The online databases Google Scholar and PubMed were used for data search. MeSH terms were used for PubMed search. Randomized controlled clinical trials, original studies and *in-vitro* studies conducted up to 2017 in the English language involving CHX mouth rinse were included in the review. Studies on rinses other than CHX, reviews and studies conducted on materials other than dental ceramics were not considered.

Results: The search generated a total of 870 results whose titles were screened and 150 titles were retrieved for abstract reading. 32 articles were selected which also contained reviews and studies done on other materials. Finally, six articles were included in the study after application of eligibility criteria, all of which were *in-vitro* experimental studies.

Conclusion: Very few studies have been conducted on the color stability of dental ceramics. The findings of this review reveal that chlorhexidine gluconate mouth-rinses do have a derogatory effect on the color stability of ceramics but these effects are lesser than those on composites and other esthetic restorative materials.

Keywords: *Chlorhexidine; Color Stability; Porcelain*

Introduction

Mankind's timeless obsession with achieving perfection in beauty and proportions has elevated the importance of esthetics in dentistry. Over the decades, materials have been developed to mimic natural teeth as closely as possible to achieve lifelike esthetics. Dental ceramic is one such material which has proven to have an appearance closest to natural teeth [1]. This material exhibits many other desirable properties like biocompatibility, low thermal conductivity, abrasion resistance and diminished plaque retention [2]. Over the past 20 years, dental ceramics have largely replaced other materials in fixed restorative prosthesis. Although systematic reviews of clinical data have shown higher clinical survival rates over a five-year period for metal ceramic restorations (94.4%) than all ceramic restorations (88.6%) [3], the latter are more desirable to the patients [4]. This is attributed to the superior esthetics of all ceramic restorations which indicates that patients prefer esthetics as much as, if not above durability. Color, shape and texture are three important characteristics of esthetics which help in personalizing a smile [5]. In fact, Burke and Qualtrough (1994) reported that 38% of patient dissatisfaction with esthetic restorations concerns color [6]. A restoration that undergoes a significant amount of color degradation can be a source of embarrassment for the dentist and the patient and is considered a major treatment failure [7]. Hence color stability is an important requirement of an esthetic restoration.

Color stability of a dental material is measured as a function of its color change value [8]. Instruments like spectrophotometers and colorimeters make it possible to evaluate color stability of materials both *in-vivo* and *in-vitro.* Various *in-vitro* trials have shown that

ceramics have far superior color stability than other esthetic materials [9,10]. Even so, studies have shown that dental ceramics exhibit discoloration when subjected to varied environmental conditions and ageing [11-13]. This discoloration is also dependent on surface treatments of ceramic restorations. A clinical study conducted by Yilmaz., *et al.* showed that the polished porcelain surface of all five porcelain products that were tested had statistically significant color deviation than the glazed surface in the same group after immersion in methylene blue which implied that glazed porcelain is more color stable than polished porcelain [14]. Dentists and patients, therefore, need to be informed about the gradual color degradation that can be expected from ceramic restorations while they are subjected to different conditions and different media.

Chlorhexidine gluconate is a cationic biguanide with broad-spectrum antimicrobial action and several clinical studies have shown its effectiveness in decreasing the formation of dental biofilm (plaque) and gingivitis [15]. It works by destabilizing the osmotic balance of microbes by binding its cationic molecules to their negatively charged cell walls [16]. Due to their prolonged broad spectrum antibacterial activity and plaque inhibitory potential, chlorhexidine mouth-rinses are often considered the "gold standard" antibacterial mouth agents [16,17]. However, its beneficial actions are not without its own deleterious effects that range from taste disturbance, enhanced supra-gingival calculus, desquamation of the oral mucosa (rarely) to tooth staining which is its most commonly observed side-effect [18]. Bagis., *et al.* reported that chlorhexidine gluconate mouth-rinse has staining effect on the natural dentition which is highest within the first few days of use [19]. Due to the staining capabilities of chlorhexidine gluconate, research has been done to study its effect on the color stability of various esthetic materials. The present review aims to summarize all the studies done with respect to the staining effect of chlorhexidine gluconate on the color stability of dental ceramics.

Methods

This review was conducted and reported in accordance with the PRISMA statement.

Focused question: "To study the effect of chlorhexidine antibacterial mouth rinses on the color stability of different dental ceramics".

Search strategy: A protocol based approach was employed to search available literature and identify relevant studies with respect to the focus question. The search was conducted in October 2017 and updated in November 2017. The search was conducted on two electronic databases, Google Scholar and PubMed. The proposed keywords for the search were - "color stability", "dental ceramics", "chlorhexidine gluconate", "antibacterial mouth-rinses" and "color degradation". Search conducted on Google Scholar employed a combination of the above-mentioned search terms in the following combinations - "color stability or color degradation" with "dental ceramics" and "chlorhexidine gluconate or antibacterial mouth-rinses".

For PubMed search, the search terms were converted into their corresponding Medical Subject Heading (MeSH) terms. The MeSH 2017 browser available in the online portal of the National Library of Medicine (NLM) was used to generate MeSH equivalents of the proposed search terms. As a consequence, dental ceramics was converted to "ceramics", chlorhexidine gluconate was retained, color stability was converted to "color", and antibacterial mouth-rinse was converted to "anti-bacterial agents, mouth". A combination of these terms was used for the PubMed search without any applied filters so as to retrieve maximum results.

An agreement on the inclusion and exclusion criteria was reached by all reviewers and the following was deemed acceptable:

Inclusion criteria

- Randomized controlled trials, original research and *in-vitro* studies.
- Articles published till 2017.
- Studies done on the effects of chlorhexidine mouth-rinses.

Exclusion criteria

- Studies conducted on materials other than dental ceramics.
- Studies measuring the effects of other liquids.
- Review articles.

Titles and abstracts of the articles generated by the online databases after entering the relevant search terms were read and assessed by application of the eligibility criteria by two reviewers. For articles whose abstracts qualified the inclusion and exclusion criteria full text was accessed. Free full text articles were downloaded directly from the search URLs generated by the database while restricted access articles were downloaded using the institutional access of King Abdul Aziz University Library.

Results

Study Selection

Electronic search conducted on the two databases viz. Google Scholar and PubMed generated a total of 870 results. The strategy employed for final selection of articles to be included in the present study is depicted in figure 1. Out of the total results, 862 were generated from Google Scholar and 8 were generated from PubMed. The generated articles were then screened by reading titles and 720 studies were removed for being unrelated or duplicate which left 150 titles. These were further scrutinized by abstract reading and 32 articles were selected which also contained reviews and articles in other languages. 24 of these were eliminated as they were not original researches while 2 of these were not in the English language. Finally, after application of all inclusion and exclusion criteria, the authors were left with six studies to be included in the final review. Full text of the selected articles was retrieved for data synthesis. The search strategy and data selection is outlined in figure 1.

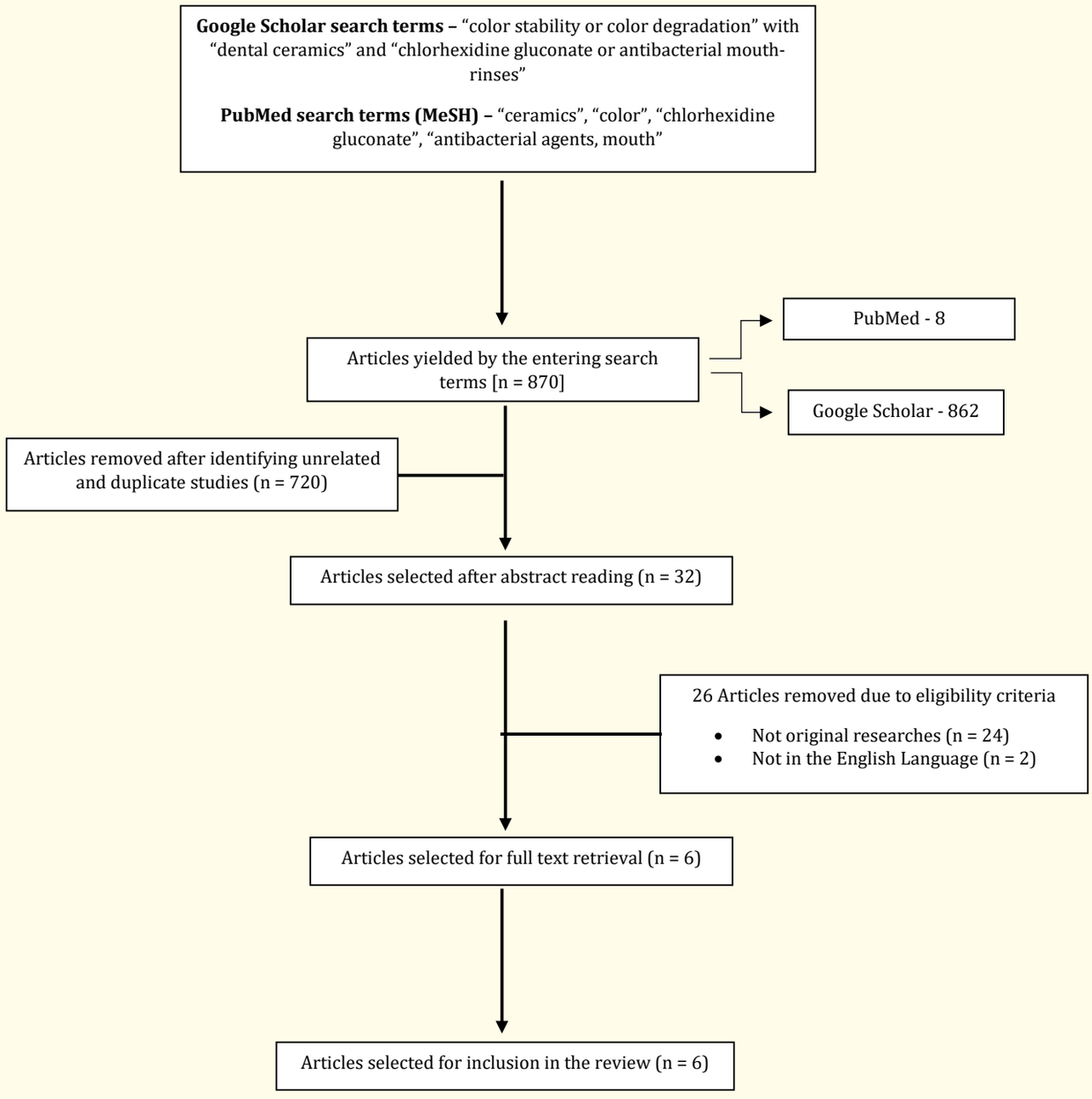

Figure 1: *Flowchart outlining the search strategy for the review.*

Description of studies

Key data extracted from the full text of the selected studies is summarized in table 1. All the studies included in this study are *in-vitro* experimental studies. Two studies (22,25) were done on disc shaped ceramic samples while one study was done on esthetic brackets (21). One study was done on cylindrical ceramic samples (20) and one study (23) was done on metal samples veneered with esthetic materials. All the studies were done on varied types of ceramic samples while one compared the ceramics with other materials (23). While one study (20) used three groups of auto-glazed, overglazed and polished feldspathic porcelain, another study used two groups of glazed and polished porcelain (22). One study (25) used feldspathic porcelain and monolithic zirconia as samples while another used different kind of reinforced ceramics (24) and still another study (23) used ceramic, ceramic repair composites and indirect composites.

Authors/ Study Design	Number and type of Subjects/ Samples	Type of Ceramics	Main Results	Main Conclusions
Derafshi R, Khorshidi H, Kalantari M, Ghaffarlou I [20] (*in-vitro* experimental)	72-disc shaped porcelains	Group A - dental direkt cube X2 (monolithic zirconia) Group B - VITA VMK 95 (Feldspathic porcelain)	Color changes occurred in the experimental groups. The ΔE*ab values were significantly greater in VMK 95 porcelain compared to cube X^2 (both $p < 0.001$) following immersion in CHX and Listerine® mouth-rinses. However no significant difference was founded when distilled water was used ($p = 0.630$). For the two materials, the ΔE values were highest in CHX, followed by the Listerine® and distilled water.	The present study showed that both monolithic zirconia and feldspathic porcelain underwent color changes after immersion in CHX and Listerine® mouth-rinses.
Soygun K, Varol O, Ozer A, Bolayir G [19] (*in-vitro* experimental)	120 ceramic samples	Lithium disilicate-reinforced ceramic material (IPS Empress CAD), Leucite reinforced ceramic material (IPS e.max CAD), Resin nanoceramic (Lava Ultimate CAD)	There was a positive correlation between the ΔE and increase in the surface roughness. Two of the ceramic materials, IPS Empress and Lava Ultimate, were affected significantly by the treatment of the mouth-rinse solutions ($P < .05$). The most affecting solution was Tantum Verde and the most affected material was Lava Ultimate. The most resistant material to ΔE and chemical corrosion was IPS e max CAD among the materials used	The mouth-rinse with lower alcohol content had less deteriorating effect on colour and on the surface morphology of the bio-ceramic materials
Kirubagaran SS [18] (*in-vitro* experimental)	60 metal samples veneered with esthetic material	Group I - ceramic (Ivoclar d sign, Ivoclar Vivadent), Group II - ceramic repair composite (Ceram X mono), Group III - indirect composite (SR Adora, Ivoclar Vivadent)	The mean color difference values ΔE for Group I, Group II, Group III were 15.95 ± 1.96, 24.25 ± 2.25, 25.32 ± 1.25 respectively. One way analysis of variance showed a statistically highly significant difference ($p < 0.001$) between the experimental groups at 5% level of significance	Ceramic veneers were the most resistant to color change induced by the fluoride mouth rinse than Ceramic repair composite and indirect veneer composite and the clinicians need to be aware of this while prescribing fluoride mouth rinses

Heydari M, Salari MH [17] (*in-vitro* experimental)	20 disc shaped ceramic samples	Group A - Glazed porcelain Group B - Polished porcelain	All the specimens displayed color changes after immersion in considered solution. Polished specimens exhibited a little bit more color change in two coordinates, but color shift of both groups were relatively the same and they were not statistically significant. 0.98 ± 0.08 and 0.81 ± 0.19 in polished and glazed group respectively	The color stability in both groups of polished and glazed porcelains are clinically acceptable, and the different surface preparation methods has no significant effect on porcelain surface discoloration in Chlorhexidine mouth rinse solutions.
Al Attar AM [16] (*in-vitro* experimental)	240 samples	120 - ceramic brackets 120 - sapphire brackets	All types of mouth wash cause staining, this effect was higher in ceramic than sapphire bracket and for no-mix than light cure bond bracket complex; the amount of staining low in Listerine, intermediate in cetrimide, high in chlorhexidine for all bracket-bond complex.	Mouthwashes generally cause some staining in esthetic brackets, chlorhexidine was found to cause the highest discoloration
Khaledi AAR, Safari A, Adibi A, Adibi S [15] (*in-vitro* experimental)	48 cylindrical specimens	Three groups (n = 16) each of overglazed (OP), auto-glazed (AP) and polished feldspathic porcelain (POP)	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).	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.

Table 1

Discussion

Summary of Findings

The present literature review searched existing literature to present the reader with an overview of the color stability of dental ceramics during repeated exposure to Chlorhexidine mouthwash, or in other words, the change in color of ceramic restorations when they are exposed to Chlorhexidine mouthwashes. To the best of our knowledge, this is the first comprehensive review that has attempted to collect and qualitatively summarize data on this topic from an in-depth reading and synthesis of six full text articles that were selected after application of eligibility criteria. A total of 560 ceramic samples were studied in the selected articles and this included monolithic zirconia, feldspathic porcelain, reinforced ceramics, over-glazed and auto-glazed ceramics, ceramic brackets and polished feldspathic porcelain. The most commonly used samples in the selected studies were glazed ceramics.

Key findings for color stability of ceramics

There has been some research when it comes to studying the color behavior of esthetic restorative materials under the influence of various types of staining agents. Gurdal., *et al.* studied the effects of three different types of mouthwashes on the color stability of resin composite, conventional glass ionomer and polyacid modified resin composite. Their study revealed that the three mouthwashes had no significant affect on color of the esthetic restorative materials as compared to distilled water and the differences observed were due to internal structural composition of the materials themselves and not due to the test solutions[26]. Similarly, Koksal and Dikbas (2008) studied the effects of staining agents such as tea, instant coffee, coke and distilled water on the color stability of various denture teeth

materials (acrylic and porcelain) and found that among the staining agents, instant coffee was found to be most chromogenic while among the materials tested, porcelain was found to be most resistant to discoloration [27]. In our present review, one study (23) compared the discoloration of dental ceramics to the discoloration of other materials with fluoridated chlorhexidine mouthwash use and concluded that the ceramic veneers were the most resistant to color change induced by the fluoride mouth-rinse as compared to ceramic repair composite and indirect veneer composite.

In full ceramic crowns, light transmission and translucency often depend upon the chemical nature of the ceramic, its crystal content, particle size and core thickness [28]. It is imperative to maintain equal thickness of the samples in order to objectively test the color characteristics of two different materials. Derafshi., *et al.* [25] attempted to compare the color changes occurring in monolithic zirconia and feldspathic porcelain, of equal thickness, when immersed in distilled water, Listerine® or CHX. They found that both the materials underwent some color changes after immersion in CHX and Listerine® mouthwashes but the ΔE*ab values were significantly greater for feldspathic porcelain than monolithic zirconia. Furthermore, they observed that for the two materials, the ΔE values were highest in CHX, followed by the Listerine® and distilled water.

Reinforced ceramics especially lithium disilicate glass ceramics are being increasingly used in the clinical setting due to higher translucency and superior esthetics than their polycrystalline counterparts [29,30]. Soygun., *et al.* [24] compared the color change in two types of reinforced ceramics (lithium disilicate reinforced [IPS Empress CAD, Ivoclar Vivadent, Liechtenstein] and leucite reinforced [IPS e.max CAD, Ivoclar Vivadent, Liechtenstein]) as well as a resin nanoceramics. They studied the effects of Listerine®, Klorhex® and Tantum Verde® on these materials and found that alcohol content in mouth-rinses has a discoloring effect on esthetic restorations. They reported that both the ceramic materials underwent significant discoloration, that IPS e.max CAD was the least discolored ceramic and the most affecting mouth rinse was Tantum Verde® followed by Klorhex®. Ceramic brackets are also increasingly being used as an esthetic alternative to metal brackets during orthodontic treatment. Both monocrystalline (translucent) and polycrystalline (non-translucent) are being manufactured which serve the esthetic needs of individual cases[31]. As reported in a few studies, these brackets are not color stable in the long run due to environmental degradation in the oral cavity as a result of pigments released from food and drinks [32,33]. A study by de Oliveira., *et al.* [34] studied the effects of four staining agents (black tea, red wine, coke and coffee) on monocrystalline and polycrystalline brackets and reported that both forms of brackets underwent color change in coffee, black tea and red wine with coffee being the strongest staining agent. This present review includes a similar study by Al Attar [21] who studied the effects of three types of mouthwashes (Listerine®, Cetrimide and Chlorhexidine gluconate) on ceramic brackets and concluded that all mouthwashes cause discoloration of the brackets with chlorhexidine gluconate having the maximum effect.

Conclusion

There are few studies available in the literature that study the effects of chlorhexidine gluconate mouthwashes on the color stability of dental ceramics. The results of this literature review establish that chlorhexidine gluconate mouth-rinses do have a derogatory effect on the color stability of ceramics but these effects are lesser than those on composites and other esthetic restorative materials. Leucite reinforced ceramics, zirconia and glazed ceramics exhibited less color change when compared to other reinforced ceramics, porcelain and polished porcelain respectively. Ceramic brackets also exhibited color change. Color stability is an important characteristic of an esthetic restoration and must be kept in mind when selecting a restorative material. The findings of this review can help the dental practitioner make informed clinical decisions on the type of material to use for each individual case.

Conflict of Interest

The authors of this research have no conflict of interest to declare.

Bibliography

1. Griggs JA. "Recent Advances in Materials for All-Ceramic Restorations". *Dental Clinics of North America* 51.3 (2007): 713.

2. Rawat A., *et al*. "Zirconium for esthetic rehabilitation: an overview". *Indian Journal of Dental Research* 22.1 (2011): 140-143.

3. Sailer I., *et al*. "A systematic review of the survival and complication rates of all-ceramic and metal-ceramic reconstructions after an observation period of at least 3 years. Part II: Fixed dental prostheses". *Clinical Oral Implants Research* 18 (2007): 86-96.

4. Esquivel-Upshaw JF., *et al*. "Randomized Clinical Trial of Implant-Supported Ceramic-Ceramic and Metal-Ceramic Fixed Dental Prostheses: Preliminary Results". *Journal of Prosthodontics* 23.2 (2014): 73-82.

5. Samra APB., *et al*. "Color stability evaluation of esthetic restorative materials". *Brazilian Oral Research* 22.3 (2008): 205-210.

6. Burke FJT and Qualtrough AJE. "Aesthetic inlays: composite or ceramic?". *British Dental Journal* 176.2 (1994): 53-60.

7. Haselton DR., *et al*. "Color stability of provisional crown and fixed partial denture resins". *Journal of Prosthetic Dentistry* 93.1 (2005): 70-75.

8. Mutlu-Sagesen L., *et al*. "Color stability of dental composites after immersion in various media". *Dental Materials Journal* 24.3 (2005): 382-390.

9. Gawreiolek M., *et al*. "Color and luminescence stability of selected dental materials in vitro". *Journal of Prosthodontics* 21.2 (2012): 112-122.

10. Koksal T and Dikbas I. "Color stability of different denture teeth materials against various staining agents". *Dental Materials Journal* 27.1 (2008): 139-144.

11. Ertan AA and Sahin E. "Colour stability of low fusing porcelains: an in vitro study". *Journal of Oral Rehabilitation* 32.5 (2005): 358-361.

12. Guignone BC., *et al*. "Color stability of ceramic brackets immersed in potentially staining solutions". *Dental Press Journal of Orthodontics* 20.4 (2015): 32-38.

13. Spyropoulou PE., *et al*. "Cyclic Loading Effect on Color Stability of Unshaded versus Shaded Zirconia". *Journal of Esthetic and Restorative Dentistry* 28.2 (2016): 77-84.

14. Yilmaz C., *et al*. "Color stability of glazed and polished dental porcelains". *Journal of Prosthodontics* 17.1 (2008): 20-24.

15. Lorenz K., *et al*. "Effect of two new chlorhexidine mouthrinses on the development of dental plaque, gingivitis, and discolouration.A randomized, investigator-blind, placebo-controlled, 3-week experimental gingivitis study". *Journal of Clinical Periodontology* 33.8 (2006): 561-567.

16. Amornchat C., *et al*. "Effect of Cha-em Thai mouthwash on salivary levels of mutans streptococci and total IgA". *Southeast Asian Journal of Tropical Medicine and Public Health* 37.3 (2006): 528-531.

17. Sheen S., *et al*. "The effect of toothpaste on the propensity of chlorhexidine and cetyl pyridinium chloride to produce staining in vitro: a possible predictor of inactivation". *Journal of Clinical Periodontology* 28.1 (2001): 46-51.

18. Addy M and Moran J. "Chemical supragingival plaque control". In: Lindhe J, Karring T, Lang NP, editors. Clinical Periodontology and Implant Dentistry. 5th edition. Copenhagen: Blackwell Mumksgaard (2008): 734-765.

19. Bagis B., *et al*. "Evaluation of chlorhexidine gluconate mouthrinse-induced staining using a digital colorimeter: an in vivo study". *Quintessence International* 42.3 (2011): 213-223.

20. Khaledi AAR., *et al*. "The Effect of Chlorhexidine Mouth Rinse on the Colour Stability of Porcelain with Three Different Surface Treatments: An in Vitro Study". *Journal of Dental Biomaterials* 1.1 (2014): 03-08.

21. Al Attar AM. "Discoloration of esthetic bracket by mouthwashes". *Journal of Baghdad College of Dentistry* 26.2 (2014): 125-130.

22. Heydari M and Salari MH. "The effect of glazing and polishing on color stability of CERAMCO III dental Porcelain in Chlorhexidine mouth rinse". *Journal of Research in Dental Sciences* 13.4 (2016): 09.

23. Kirubagaran SS. "Effect of fluoride mouth rinses inducing color change in esthetic veneer restoration -a spectrophotometric analysis". *Journal of Pharmaceutical Sciences and Research* 8.4 (2016): 210-213.

24. Soygun K., *et al*. "Investigations on the effects of mouthrinses on the colour stability and surface roughness of different dental bioceramics". *The Journal of Advanced Prosthodontics* 9.3 (2017): 200-207.

25. Derafshi R., *et al*. "Effect of mouthrinses on color stability of monolithic zirconia and feldspathic ceramic: an in vitro study". *BMC Oral Health* 17.1 (2017): 129.

26. Gürdal P., *et al*. "The effects of mouthrinses on microhardness and colour stability of aesthetic restorative materials". *Journal of Oral Rehabilitation* 29.9 (2002): 895-901.

27. Koksal T and Dikbas I. "Color stability of different denture teeth materials against various staining agents". *Dental Materials Journal* 27.1 (2008): 139-144.

28. Heffernan MJ., *et al*. "Realtive translucency of six all-ceramic systems. Part I: core materials". *Journal of Prosthetic Dentistry* 88.1 (2002): 4-9.

29. Traini T., *et al*. "The zirconia-reinforced lithium silicate ceramic: lights and shadows of a new material". *Dental Materials Journal* 35.5 (2016): 748-755.

30. Raptis NV., *et al*. "Optical behavior of current ceramic systems". *International Journal of Periodontics and Restorative Dentistry* 26.1 (2006): 31-41.

31. Lopes Filho H., *et al*. "Influence of optical properties of esthetic brackets (color, translucence, and fluorescence) on visual perception". *American Journal of Orthodontics and Dentofacial Orthopedics* 141.4 (2012): 460-467.

32. Ghafari J. "Problems associated with ceramic brackets suggest limiting use to selected teeth". The Angle Orthodontist 62.2 (1992): 145-152.

33. Bishara SE. "Ceramic brackets: a clinical perspective". *World Journal of Orthodontics* 4.1 (2003): 61-66.

34. De Oliveira CB., *et al*. "In vitro study of color stability of polycrystalline and monocrystalline ceramic brackets". *Dental Press Journal of Orthodontics* 19.4 (2014): 114-121.

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