

Staining of esthetic brackets by plaque disclosing solutions

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Abstract

Aim: To evaluate the staining of esthetic orthodontic brackets by plaque disclosing solutions. **Methods:** Two types of brackets manufactured by GAC/DENTSPLY® were evaluated: ceramic (n=30) and polycarbonate (n=30). The brackets were divided into 6 groups. Two control groups (n=6) were immersed in absolute ethanol: GI - ceramic brackets and GII - polycarbonate brackets. Four experimental groups (n=12) were immersed in different plaque disclosing solutions: GIII (ceramic brackets) and GIV (polycarbonate brackets) were immersed in Replak®; GV (ceramic brackets) and GVI (polycarbonate brackets) were immersed in Replasil "S"®. Relative quantitative analysis of the influence of plaque disclosing tablets on bracket staining was performed using reflectance spectrophotometry of stain deposition. Exploratory analysis of the data was performed using Analysis of Variance (ANOVA) in a 2x2 factorial setup (bracket x immersion) with additional treatments (controls). **Results:** The results demonstrated that the ceramic brackets presented the highest amount of staining when Replasil "S"® was used (p<0.05). However, when Replak® was used, no statistically significant difference was found in comparison with the control group (p>0.05). For polycarbonate brackets, staining was detected for both disclosing solutions (p>0.05). **Conclusions:** The disclosing solutions caused stain formation on polycarbonate brackets and, under the tested conditions, use of Replak® on ceramic brackets did not cause staining.

Keywords: orthodontic brackets; spectrophotometry; biofilms.

Introduction

The strategy of applying a tailored preventive program for each patient, considering both the risk to plaque-related disease and the level of adherence to the necessary measures, is mandatory for a satisfactory correction of occlusion without compromising the oral tissue health¹⁻³.

The dental materials industry has been investing in manufacturing custom brackets that combine both adequate esthetics and technical performance⁴.

The first esthetic brackets developed in the 1960s were made of polycarbonate⁵, which presented disadvantages in terms of clinical performance such as deformation, structural fragility, low adhesion and superficial staining⁶⁻⁸. Consequently, the use of such appliances was recommended with caution and was limited to short

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times of treatment. These materials present unique features that must be fully understood by orthodontists so they can prescribe them safely, taking the adequate clinical care to select the cases that would benefit most from the treatment with esthetic brackets⁹.

Ceramic orthodontic brackets were first made available in the late 1980s with the aim of eliminating the esthetic issue imposed by metallic brackets and the disadvantages of polycarbonate brackets. The early appliances represented significant clinical and esthetic advances due to their shade stability and resistance to oral fluids¹⁰⁻¹⁵.

The advantages and disadvantages of polycarbonate and ceramic brackets have been investigated *in vitro*, especially in terms of changes in optical properties due to discoloration and staining by pigmented substances from foods and drinks^{9,16-20}. The latter aspect is of great importance to orthodontists as patients become increasingly demanding of appliances that do not show and remain as such, especially in terms of shade^{16,21-25}. The optical properties of esthetic brackets have a direct influence on visual perception²⁶.

Once bonded, brackets make oral hygiene more difficult and may serve as a retention sites for stagnation of foods and bacterial biofilm accumulation, increasing the risk of enamel demineralization and periodontal problems²⁷.

Mechanical plaque removal using a toothbrush is the best-known and readily available method for prevention and control of such problems, which may be effective if performed appropriately. Plaque disclosing substances should also be part of the educational process, since they play a fundamental role of guiding and motivating orthodontic patients to tooth brushing, and among the available plaque disclosing solutions, basic fuchsin and Replak[®] are largely used in clinical practice²⁸.

The purpose of tooth brushing should not be limited to the automatic and mechanical fulfillment of a mere cosmetic ritual, but it must achieve an adequate disorganization of the bacterial biofilm. Passing this message across clearly to the patients, so that they are motivated throughout the course of orthodontic treatment, is no easy task. Effective communication between patients, parents, orthodontists and general dental practitioners must be in place in order to reduce the incidence of white lesions in patients wearing fixed orthodontic appliances²⁹.

Studies on the possible shade changes caused by known pigmented solutions such as Coca-Cola[®], tea, coffee, red wine, etc. to polycarbonate and ceramic brackets have been performed^{17,21}. There is, however, a lack of reports on the degree of staining of such appliances by plaque disclosing solutions. This could partially explain why most orthodontists avoid procedures of plaque disclosure prior to prophylaxis and patients prior to brushing, in other words, there is no scientific evidence that such dyes will not cause staining of polycarbonate and ceramic brackets.

The purpose of this study was to evaluate whether esthetic brackets are stained by different plaque disclosing solutions.

Material and methods

The study sample was composed by 60 esthetic brackets,

30 ceramic and 30 polycarbonate, from GAC/Dentsply (Islandia, NY, USA) for the maxillary right central incisor (11).

The brackets were divided into 2 control groups (n=6) and 4 experimental groups (n=12). Two disclosing solutions Replak[®] (Dentsply, Petrópolis/RJ, Brazil), based on red and blue food dyes and Replasil "S"[®] (Iodontosul, Porto Alegre/RS, Brazil), based on 0.04% basic fuchsin and two types of esthetic brackets [ceramic (Mystique Mb[®], Dentsply/GAC, Bohemia, NY)] or polycarbonate (Elation Mb[®], Dentsply/GAC, Bohemia, NY) were used. The groups were named GI (control), esthetic ceramic brackets immersed in absolute ethanol; GII (control), esthetic polycarbonate brackets immersed in absolute ethanol; GIII, esthetic ceramic brackets immersed in Replak[®], GIV; esthetic polycarbonate brackets immersed in Replak[®]; GV, esthetic ceramic brackets immersed in Replasil "S"[®]; and GVI, esthetic polycarbonate brackets immersed in the plaque disclosing solution Replasil "S"[®].

The relative quantitative analysis of the influence of plaque disclosing solutions on shade changes of brackets by stain deposition was performed using Reflectance Spectrophotometry^{17,21,30-31}. An amount of 250 μ L of each dye and ethanol was pipetted into the wells of a 96-well plate. In order to avoid cross-contamination of dyes through spillage, the pipetting sequence was: Replak[®], Replasil "S"[®] and ethanol.

Each well received one type of bracket using dental tweezers. All brackets remained immersed in ethanol (control group) and in their respective plaque disclosing solution for 1 h. The plates were kept at room temperature in the dark, preventing the interference of light in shade change of the brackets^{17,21}.

The test specimens were removed using a pair of tweezers and rinsed in distilled water by immersion for 15 s in the appropriate well of a 24-well plate^{17,21,30}. The brackets were subsequently dried in absorbent paper for 1 min, always following a random sequence³⁰⁻³¹.

The brackets were then immersed in 250 μ L absolute ethanol in the wells of a 96-well plate³⁰⁻³¹ which was placed in an orbital shaker (Biomixer, Chatswood, NSW, Australia) for 24 h to elute the dye that was deposited onto the specimen. The brackets were removed from the wells and the plate was placed in a reflectance spectrophotometer (Epoch - Biotek[™] Instruments, Inc., Winooski, VT, USA) to quantify and observe the degree of absorbance of the experimental solutions, which was registered and printed using the Gen 5TM Getting Started Guide (Biotek[™] Instruments, Inc. - Dec. 2009) software. Readings were taken from the absorption spectrum peaks, since each dye showed better results at different wavelengths. The readings for each solution were compared against the control group within the same absorbance spectrum³⁰⁻³¹.

In order to establish the relationship between the absorbance of the red and blue solutions (Replak[®]) and 0.04% basic fuchsin (Replasil "S"[®]), the spectrophotometer was calibrated at the of 600 and 550 nm wavelengths, respectively (maximum absorbance spectrum of each solution).

The exploratory analysis of the data required a square root adjustment so that the values fulfilled the assumptions

of a parametric analysis. Analysis of Variance (ANOVA) was then applied using a 2x2 factorial setup (bracket x immersion) and additional treatments (control groups). For Replak[®], ethanol measured at a wavelength of 600 nm was considered, whilst for Replakul “S”[®], ethanol was measured at 550 nm, always with the respective bracket type. The comparisons with the controls were performed using the Dunnett’s test with $p=0.05$. All analyses were performed using the statistics SAS software (SAS Inc., Cary, NC, USA).

Results

Table 1 shows the amount of staining of the studied esthetic brackets. For the ceramic brackets, the highest degree of staining was observed with Replakul “S”[®] ($p \leq 0.05$), whereas for the polycarbonate brackets no significant difference was found between the tested disclosing solutions ($p > 0.05$), but staining was observed for both products.

Regarding the plaque disclosing solutions, Replak[®] on polycarbonate brackets caused the highest average stain readings ($p \leq 0.05$). The use of Replak[®] on ceramic brackets did not show statistically significant difference against the control group ($p \leq 0.05$).

Table 1. Mean staining (standard deviation) according to type of bracket and immersion solution

Immersion	Bracket type	
	Ceramic	Polycarbonate
Ethanol (550 nm control Replakul)	0.08 (0.06)	0.06 (0.02)
Ethanol (600 nm control Replak)	0.06 (0.03)	0.05 (0.01)
Replak	0.11 (0.05) Bb	*0.17 (0.07) Aa
Replakul “S”	*0.27 (0.06) Aa	*0.19 (0.09) Ba

Means followed by different letters (uppercase horizontally and lowercase vertically) indicate significant difference ($p < 0.05$). * Different from the ethanol group for the same bracket type ($p < 0.05$).

Discussion

The present study assessed the shade changes caused by plaque disclosing solutions on polycarbonate and ceramic brackets using reflectance spectrophotometry. This method aims to determine the concentration of a substance generally present in a solution, using a known concentration of the same compound as a reference³¹. It is a method previously used to quantify a dye that impregnates specimens^{17,21,30-31} and it is in an analytical technique to quantitatively determine chemical species.

The results demonstrated that the use of a fuchsine-based plaque disclosing solution (Replakul “S”[®]) caused the ceramic bracket to present the highest degree of staining, however, when Replak[®] was used, no difference was observed when compared with the control group, suggesting that this disclosing solution was not adsorbed onto the bracket surface in the time adopted for this study, thus causing no shade change to the bracket. Therefore, the use of Replak[®] on ceramic brackets did not cause staining, suggesting it as the

plaque disclosing solution of choice for patients undergoing orthodontic treatment. Previous studies have reported that ceramic brackets are stain and discoloration resistant to any chemical substance encountered in the oral environment, which contradicts the findings from this study^{10-13,23}.

Esthetic material can undergo shade or color change due to both extrinsic and intrinsic factors. According to some authors^{10,14,18-19,27} the intrinsic factors include the material discoloration itself, as a result of matrix changes (ageing, physicochemical conditions such as visible light radiation, ultraviolet rays and moisture) and the extrinsic factors include absorption and adsorption of substances. Consequently, it is possible to infer that the fuchsine-based disclosing solution bonded to the ceramic both intrinsically and extrinsically via incorporation of the dye into the bracket. The food dyes present in Replak[®], however, did not show intrinsic or extrinsic affinity to the ceramic when compared with the control group, thus making it the plaque disclosing product of choice for patients wearing esthetic ceramic brackets. This corroborates other reports on the esthetic advantages of ceramic over polycarbonate brackets^{9,14,16,18-22,24-25,27}; however, ceramic brackets can also be stained³⁰. According to a study that evaluated the chromatic changes of some types of ceramic brackets, the results demonstrated that the discolorations were significant when time was taken into account for all tested solutions¹⁷.

This study demonstrated the staining of polycarbonate brackets by both disclosing solutions Replakul “S”[®] and Replak[®], showing that shade or color change by extrinsic physicochemical factors were observed in this type of material. Another study reported clinical problems with discoloration when using polycarbonate brackets even in the absence of a dye¹⁸, despite the excellent hardness of such resin material, thus corroborating the results from this study.

As reported in the literature, polycarbonate and ceramic brackets have different patterns of color or shade change for each solution used^{6-9,14,16,18,22,24-25,27}. The present study corroborates those findings in terms of changes to optical properties of such brackets in the oral environment, as a result of staining by coloring substances present in foods and beverages^{9,16-17,21-22,24-25}.

The planning of orthodontic treatment either due to esthetics or for oral health purpose^{3,13} must include strategies of plaque control and, the use of plaque disclosing solutions must not be dismissed from the motivational arsenal and home care kit. Therefore, further studies are needed on the factors that interfere with color and shade stability of such devices, since the demand for more discrete appliances increases rapidly, just as the optical properties of esthetic brackets are the least investigated directly⁹.

This study demonstrated that plaque disclosing agents might interfere with bracket shade. The choice of the most appropriate product for each bracket type should be cautious. The findings from this study suggest that patients wearing ceramic brackets ought to opt for Replak[®]. The tested plaque disclosing products caused color changes on polycarbonate brackets, which should be further investigated clinically to determine its relevance for patients wearing such appliances.

In conclusion, the plaque disclosing solutions tested in this study should not be used on polycarbonate brackets and, under the conditions described in this study, the use of Replak® on ceramic brackets did not cause staining.

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