Academic Journal of Oral and Dental Medicine 1 (2): 05-09, 2014
ISSN 2222-128X

DOI: 10.5829/idosi.ajodm.2014.1.2.82388

Evaluation of Colour Stability of Three Polycrystalline Ceramic Brackets in Three Commonly Consumed Beverages- An *In-vitro* Study

M.S. Kannan, Rachana Saboo, S. Kishore Kumar and R.V. Murali

Department of Orthodontics,
Sree Balaji Dental College and Hospital, Chennai, India

Abstract: The introduction of ceramic brackets revolutionized the field of orthodontics. They were introduced as an esthetic appliance having the advantages of permanent translucency and greater strength. However, from the esthetic point of view, they do tend to discolor from food stains.Aim: The purpose of this study was to assess the colour stability of three polycrystalline ceramic brackets, by three commonly consumed beverages. Materials: 40 upper right central incisor ceramic brackets of 3 different companies were taken. The beverages selected were Tea, Coffee and Coca-Cola. The color testing was done using a Spectrophotometer. Methods: the brackets were immersed in the beverages for 1, 3 and 6 days and the color change was measured.Results: that All the bracket systems showed considerable color changes in tea and coffee. The color change in coca-cola was minimal.

Key words: Poly crystalline Ceramic Brackets · Colour stability · Food stains · Beverages

INTRODUCTION

Characteristics of an ideal orthodontic appliance include good esthetics and optimum technical performance. In recent years the esthetics of the orthodontic appliance has become a topic of great interest with increasing number of adult patients seeking orthodontic treatment.

This led to the development of various esthetically superior appliances. The superior esthetics of ceramic brackets compared to conventional stainless steel brackets is not only well accepted by the patient, particularly adults, but also are positively sought for.

Ceramic brackets were introduced in Orthodontics in the 1980's and their characteristics were described in detail by Michael L. Swartz [1]. Joseph Ghafari [2] in his extensive review article, highlighted the problems associated with ceramic brackets. The problems included attrition of teeth occluding against ceramic brackets; increased friction; breakage of bracket wings while engaging a heavy archwire, limited rotation of teeth; staining of brackets due to individual diets-prolonged use of caffeine (Coffee, tea, colas), enamel fracture and flaking or fracture lines in enamel during debonding; increased pain or discomfort while debonding, operational risk for the patient due to accidental ingestion or aspiration of a bracket during bonding or debonding.

The purpose of this study was to take into consideration, the staining of the brackets due to individual diets and to evaluate the effect of three commonly consumed beverages; tea, coffee and coca-cola upon colour stability of ceramic brackets.

Aims and Objectives: The aims and objectives of the study were

- To assess the discolouration of three polycrystalline ceramic brackets, by three commonly consumed beverages.
- To identify the ceramic bracket showing maximum discoloration.
- To identify the beverage having the highest staining capacity.
- To find out the co-relation between surface roughness and extent of discolouration.

Corresponding Author: Kannan sabapathy, Department of Orthodontics,
Sree Balaji Dental College and Hospital, Chennai, India. E-mail: kannanace@gmail.com.

TRANSCEND 6000 INTRIGUE 20/40

Fig 1: Bracket Samples

Fig 2: Spectrophotometer (Gretagmacbeth Spectrolino Type)

MATERIALS AND METHODS

This in-vitro study was carried out on 120 upper right central incisor ceramic brackets of three different companies (40 each). Three commonly consumed beverages (Tea, coffee, coca cola) were selected for the study and distilled water was taken as control.

The brackets used in the study were Transcend 6000 (3M Unitek, Monrovia, CA), Intrigue (Lancer Orthodontics, Vista, CA) and 20/40 (American Orthodontics, Sheboygan, Wis) (Fig. 1).

The beverages used were Yellow Label Tea (Lipton, Hindustan Lever, Mumbai), Nescafe Classic Coffee (Nestle India Limited, New Delhi) and Coca-Cola (Hindustan Coca-Cola India, Gurgaon).

The color analysis was done using a hand held spectrophotometer (GretagMacbeth Spectrolino type, Regensdorf, Switzerland) (Fig. 2).

The standard solutions for the beverages were prepared [3]. The brackets were divided into 4 groups of 10 each and were immersed in their respective standard solutions.

Color readings of the brackets were taken before immersion in the solutions (Base reading) and then after immersion in the solutions at the end of days 1, 3 and 6. These corresponded with the total in-vivo exposure values of 1, 3 and 6 months respectively [4], not taking into the account the various other factors of an in-vivo study.

The color readings were recorded in a personal computer using Optiview Lite Software (GretagMacbeth, Regensdorf, Switzerland) [5]. The color changes were determined using the Standard Commission Internationale de L'Eclairage (CIE) calorimetric techniques [6]. The colour was expressed in terms of CIE $L^*a^*b^*$ coordinates. The color change, ΔE^*, of the value 3.3 was considered to be visually perceptible [7].

The obtained data was analyzed statistically using SPSS for Windows (SPSS Inc, Chicago, IL). The analyses used were Mean and Standard deviation, along with ANOVA.

The brackets (1 each) were also evaluated for surface roughness by SEM (Hitachi, S-3400 N, Hitachi India Trading Pvt. Ltd., New Delhi), before and after the staining process to check for any co-relation between surface roughness and staining capacity.

RESULTS

All the ceramic brackets immersed in tea and coffee showed clinically perceptible discoloration (Fig. 3). The brackets immersed in coca-cola also showed staining, but only to a very minimal extent.

Fig 3: Visual color change of transcend 6000 bracket

Table 1: Δ*E** Changes in Tea

Tea						
	Day					
	Day 1		Day 3		Day 6	
Bracket	Mean	SD	Mean	SD	Mean	SD
Transcend	3.083	0.46	3.592	0.77	5.055	0.62
Intrigue	3.255	0.39	4.160	0.34	4.984	0.49
20/40	4.311	1.03	4.657	0.47	5.088	0.58
p value	<0.001		<0.001		NS	

Table 2: Δ*E** changes in coffee

Coffee						
	Day					
	Day 1		Day 3		Day 6	
Bracket	Mean	SD	Mean	SD	Mean	SD
Transcend	3.631	1.02	3.613	0.55	4.160	0.58
Intrigue	4.312	0.72	5.272	0.59	5.353	0.82
20/40	2.689	0.78	4.015	0.39	4.879	0.85
p value	<0.001		<0.001		<0.001	

Table 3: Δ*E** changes in coca-cola

Coca-Cola						
Bracket	Day					
	Day 1		Day 3		Day 6	
	Mean	SD	Mean	SD	Mean	SD
Transcend	2.462	0.87	1.980	0.43	2.216	0.47
Intrigue	1.404	0.36	2.159	0.29	2.727	0.47
20/40	3.095	0.76	2.879	0.48	3.634	0.53
p value	<0.001		<0.001		<0.001	

At the end of day 1, tea caused color changes in 20/40 brackets only. Changes were seen in Transcend 6000 and Intrigue at the end of day 3, with further staining at the end of day 6 (TABLE 1). Coffee caused discoloration of Transcend 6000 and Intrigue brackets after 1 day and the 20/40 brackets after 3 days, with significant changes seen after 6 days (TABLE 2). Coca-cola only caused discoloration of 20/40 brackets at the end of day 6. No other brackets showed changes after immersion in coca-cola (TABLE 3).

The SEM studies done on the brackets showed subsurface staining of the samples, but no co-relation could be found between the surface roughness of the brackets and the staining values (Fig. 4).

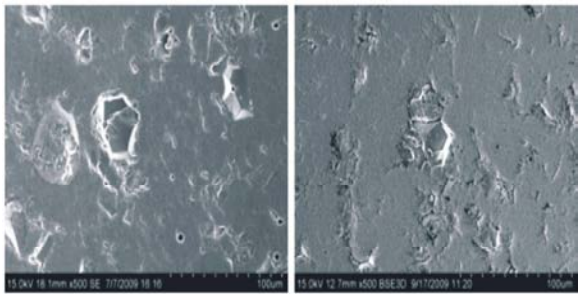

Fig 4: Sem photograph of transcend 6000 brackets

DISCUSSION

The color changes of the ceramic brackets can compromise the esthetic needs of the patient over the duration of the treatment. The change occurring can be difficult to distinguish visually, but is very evident through colorimetric measurements [7].

Different authors have proposed different values for the interpretation of ?*E*. R. R. Seghi et al.[11] stated that two objects having a Δ*E* value of approximately one unit have been judged by human observation to be an acceptable colour match 50% of the time. Ruyter IE *et al.* [7] showed that 50% of the observers considered that sample pairs were unacceptable when the colour difference (Δ*E*) was approximately 3.3. In this study, we used the value of 3.3.

In this in-vitro study, tea and coffee caused considerable color changes, when compared to coca-cola. All the three bracket systems were stained at the end of 6 days. Similar findings were reported by Stober *et al.* [8], Debra R. Haselton *et al.* [9], R. Nishiura *et al.* [10] and Susanne Wriedt *et al.* [11], in their studies.

The results of the study, however were contradictory with the findings of Hyo-Jin Kim *et al.* [12], Adriana Postiglione Buhrer Samra *et al.* [13], Temel Koksal *et al.* [14].

Yoshiaki Tanizawa *et al.* [15] dealt with the phenomena occurring on the surface of porcelain tiles immersed in tea infusion. They mentioned that tea contains two major groups of pigments, theaflavins (TFs) and thearubigins (TRs), which are produced by the oxidative polymerization in the fermentation processes. The unsightly coloured tea stain, however, is not simply caused by the adsorption of those pigments from the tea infusion, but also as a result of chemical reactions. The stains consist mainly of complexes of caffeine with the oxidative products of polyphenols and other inorganic compounds [16].

Erik Kissa [17] mentioned that coffee stains are mainly caused by the water-soluble and acidic coloured substances in coffee. The acidic nature of coffee stain has been shown by ultraviolet and visible spectroscopy of coffee as a function of pH; ion-pair formation with a cationic surfactant [18].

The microscopic observation of the stained samples showed that discolouration was mainly due to stain adsorption and sub-surface stain absorption taking place between the staining beverage and the ceramic brackets. This finding is in concurrence with the findings of Didier Dietschi *et al.* [19].

CONCLUSION

The color change (ΔE) of 3.3 was considered to be clinically unacceptable. In this study, even after a short immersion time of 6 days, all the samples showed undesirable color changes, in tea and coffee.

Nevertheless, it is important to emphasize the impossibility of establishing the exact correlation between in-vitro and in-vivo tests, since the oral environment cannot be reproduced in the laboratory and orthodontic appliances are never subjected constantly to staining media for such a long period of time. Moreover the cleansing mechanism of saliva and the mechanical cleaning by toothbrush cannot be considered in the in-vitro setting.

REFERENCES

1. Michael L. Swartz, 1988. Ceramic Brackets, JCO, 22(2): 82-88.
2. Joseph Ghafari, 1992. Problems associated with ceramic brackets suggesting limiting use to selected teeth; Angle Orthodontist, 62(2): 145-152.
3. Yu-lin Lai, Ho-fu Lui and Shyh-yuan Lee, 2003. In vitro color stability, stain resistance and water sorption of four removable gingival flange materials; Journal of Prosthetic Dentistry, 90(3): 293-300 An in vitro.
4. Ahmet Umut Guler, Fikret Yilmaz, Tolga Kulunk, Eda Guler and Safak Kurt, 2005. Effects of different drinks on stainability of resin composite provisional restorative materials; Journal of Prosthetic Dentistry, 94(2): 118-124.
5. New Products, 1997. Optiview Lite; Journal of Automatic Chemistry, 19(5): 187-191.
6. Stephen F. Rosenstiel and William M. Johnston, 1988. The effects of manipulative variables on the color of ceramic metal restorations; Journal of Prosthetic Dentistry, 60(3): 297-303.
7. Ruyter, I.E., K. Nilner and B. Moiler, 1987. Color stability of dental composite resin materials for crown and bridge veneers; Dental Materials, 3: 246-251.
8. Stober, T., H. Gilde and P. Lenz, 2001. Color stability of highly filled composite resin materials for facings; Dental Materials, 17: 87-94.
9. Debra, R. Haselton, Ana M. Diaz-Arnold and Deborah V. Dawson, 2005. Color stability of provisional crown and fixed partial denture resins; Journal of Prosthetic Dentistry, 93(1): 70-75.
10. Nishiura, R., S. Nomura, S.L. Rolland, Y. Momoi and A. Kohno, 2005. Bleaching effect found in discolored resin-based restoratives in vitro; The IADR/AADR/CADR 80th General Session, Seq #188-Polymer Materials: Shade Stability and Selection, Photopolymerization
11. Susanne Wriedt, Ulf Schepke and Heiner Wehrbein, 2007. The Discoloring Effects of Food on the Color Stability of Esthetic Brackets-an In-vitro Study; Journal of Orofacial Orthopedics, 68: 308-320.
12. Hyo-Jin Kim, Seong-Joo Heo, Jai-Young Koak and Ik-Tae Chang, 2002. Color Stability Of Current Prosthetic Composites Under Accelerated Aging And Immersion In A Coffee Solution; Journal of Korean Academy of Prosthodontics, 40(3): 225-235.
13. Adriana Postiglione Buhrer Samra, Stella Kossatz Pereira, Leyla Cotrina Delgado and Christiane Phillipini Borges, 2008. Color stability evaluation of aesthetic restorative materials; Brazilian Oral Research; 22(3): 205-210.
14. Temel Koksal and Idil Dikbas, 2008. Color Stability of Different Denture Teeth Materials against Various Staining Agents; Dental Materials Journal; 27(1): F139-144.
15. Yoshiaki Tanizawa, Tetsuya Abe and Kaoru Yamada, 2007. Black tea stain formed on the surface of teacups and pots. Part 1, Food Chemistry, 103: 1-7.
16. Observations on the Biological Effects of Black Cumin Seed (Nigella sativa) and Green Tea (Camellia sinensis) Observations on the Biological Effects of Black Cumin Seed-kawther.s.zaher) Global Veterinaria, 2008, 2(4): 198-204.

17. Erik Kissa, 1995. Coffee Stain on Textiles. Mechanisms of Staining and Stain Removal; Journal of the American Oil Chemists' Society, 72: 793-797.
18. Pushpa, S., 2012. Murthy-Extraction, Characterization and Bioactivity of Coffee Anthocyanins. European Journal of Biological Sciences 4(1): 13-19.
19. Didier Dietschi, Gaetano Campanile, Jacques Holz and Jean-Marc Meyer, 1994. Comparison of the color stability of ten new-generation composites: An in vitro study; Dental Materials, 10: 353-36.