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Comparative evaluation of color stability of four provisional restorative materials: An invitro study

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Abstract

Purpose: The present invitro study was conducted to evaluate and compare the colour stability of four commercially available provisional restorative materials.

Methods and Material: In the present study a customized 3 piece brass mold with the middle section of (2mm thick & 7mm diameter) was used to fabricate auto polymerizing bis-acryl resin specimens. 30 samples were prepared for each group and checked for colour stability in coffee and tea. One way Analysis of variance (ANOVA) and post hoc test was done for inter comparison between groups.

Results: The findings from the study show the mean reflectance value of structure 2 SC was 22.839 followed by Systemp c & b with 21.699, Integrity with 21.186 and Protemp with a mean of 21.036.

Conclusion: Structure 2 Sc (Voco) displayed the more color stability and followed by system c & b and Integrity and protemp 4.

Keywords: Colour, Provisional restorative materials, Discoloration, Spectrophotometer

Introduction

Discoloration of restoration is one of the primary reasons for replacement of prosthesis. Discoloration of the prosthesis may be influenced by extrinsic and intrinsic factors. Extrinsic factor depends on oral hygiene, saliva, eating, drinking and smoking habits such as tea, coffee and beverages. As restorations will be continuously exposed to oral environment for a long or short period of time there are more chances of discoloration.[1-8] Discoloration can be evaluated by instrumental or visual techniques. Spectrophotometer is used to assess the intensity of colour change in the study.[9]

By definition "A spectrophotometer is scientific standardized colorimetric equipment for matching and measuring color that gives information about reflectance curve as a function of wavelength in entire range."[10]

The purpose of the study was to evaluate the effect of coffee and tea on color stability of four different commercially available provisional restorative materials.

Materials and Methodology

The present study was conducted to evaluate the effect of coffee and tea on color stability of four different commercially available provisional restorative materials.

a. **Description of The Mold**: A 3 piece brass mold was machined (Fig. 1). The middle section of the mold was 2 mm thick and 7 mm in diameter circle in the centre.[11] The top and bottom sections were flat and two lock screws were used to secure the mold during curing

Four composite based self cure provisional restorative materials namely Integrity, Structure 2SC, System C & B, Protemp 4 were used.

Fig. 1: Three Piece Brass Mold

b. **Fabrication of the Specimen**: The samples were prepared by dispensing the material from auto mixing gun supplied by the manufacturer and packed in the mold space at room temperature and was allowed to cure under a standard load. A total number of 30 samples were prepared from each material measuring 2 mm thickness and 7 mm in diameter. Once the disks were fabricated, they were ground with the silicon carbide bur to remove any superficial layer of set material and polished to high gloss. All the disks were rinsed thoroughly to remove debris and stored in distilled water which served as control (Fig. 2).

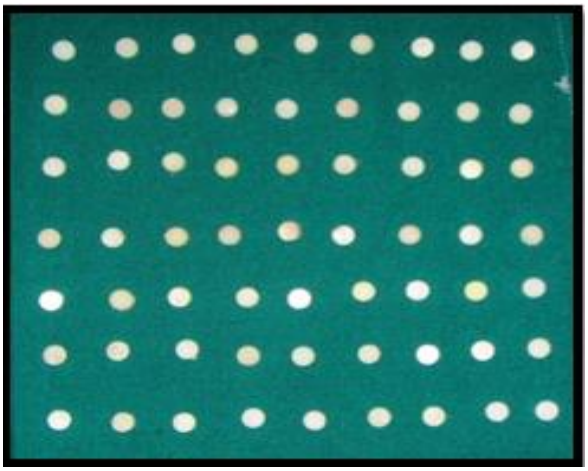

Fig. 2: Samples

c. **Preparation of Staining Solution:** The staining solutions were prepared in the following concentrations:

Coffee (Nescafe, New Delhi, India): For preparation of the coffee solution 2.8g of coffee was weighed in an electronic machine and added to 500 ml of boiling distilled water.

Tea (Lipton, Mumbai, India): For preparation of tea solution 4 tea bags were dipped in 500 mL of boiling distilled water.[12] The solutions were filtered using filter paper.

To evaluate the color stability in coffee and tea solutions, 10 specimens of each group were immersed in coffee solution and tea solution and 10 specimens of each group were used as control. Color measurements were made after 7 days of immersion. The solutions were changed every day and the specimens were rinsed for 5 minutes with distilled water and blotted dry with the tissue paper before color measurement.

d. **Assessment of Color Change**: Baseline color measurement of all specimens was measured using reflectance spectrophotometer. For baseline color measurement each specimen was placed on the measuring head of spectrophotometer which was covered with the black cover. Before each measurement session the spectrophotometer (Specord S-600, Analytik Jena, UK) was calibrated according to the manufacturer recommendations using the supplied white calibration standard. The spectrophotometer automatically calculated the mean color measurement of 10 specimens of each material. This measurement was taken as the baseline measurement for the corresponding material to evaluate the color change after immersion in different beverages. The color measurement was done at baseline and at a time interval of 7 days. The mean between four groups was statistically analyzed using two way analysis of variance and the intercomparison between the materials was done with the post hoc test.

Results

The findings from (Table 1) show the mean reflectance value of structure 2 SC was 22.839 followed by Systemp c & b with 21.699, Integrity with 21.186 and Protemp with a mean of 21.036.As shown in (Table 2) control group has a mean of 23.078, coffee group has a mean of 20.744 and tea group of 22.383 and hence it is clearly evident that coffee stains less when compared to tea and control.

(Fig. 3) indicates the interaction plots of color stability of material Vs beverages where inference can be drawn that there is interaction effect and it was also found to be significant and the behavior of material is different with different beverages and we can also observe that the color stability is high in tea when compared to coffee.

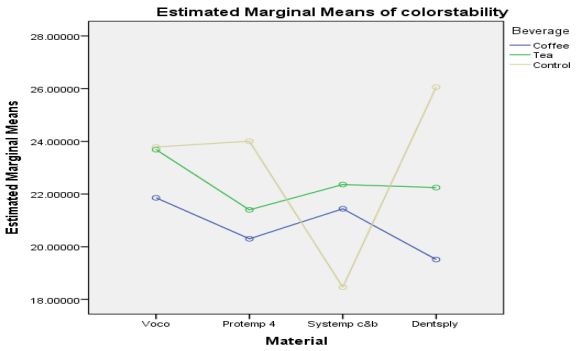

Fig. 3: Interaction plots of color stability of (materials vs beverages)

It is observed from (Table 3) (two way ANOVA) that $p < 0.05$ and here values were found to be statistically significant. The post hoc test results showed that there is significant difference between structure 2sc and other materials, where as there is no evidence of statistical significance between the rest of the other pair wise comparisons (Table 4). (Table 5) shows the post hoc test results for beverages and results showed that except between tea and control beverages there is a statistically significant difference between coffee and tea and coffee and control.

(Fig. 4) indicates the interaction plots of color stability of beverages vs materials ,where the behavior of the beverage is not the same with all the materials, there is an interaction effect and is found to be significant therefore we can conclude that the beverages is different with different materials.

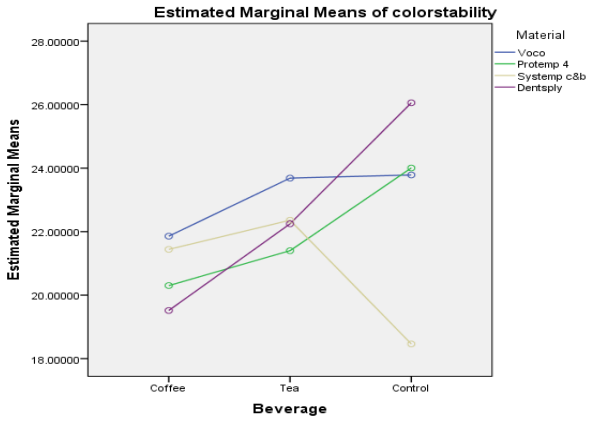

Fig. 4: Interaction plots of color stability of (beverages vs materials)

Discussion

Discoloration of provisional restorations can be an esthetic problem and looses patient's confidence. Inspite of the addition of chemical stabilizers to decrease the chemically induced color changes, provisional restorative materials are prone to absorption of liquids, so staining can easily produce color stability.[13]

Spectrophotometers have been shown to be more accurate in measuring the color change than colorimeters. Colorimeter generally uses three to four silicon photodiodes that have spectral correction filters that closely simulate the standard observer functions. These filters act as analog function generators that limit the spectral characteristics of the light that strikes the detector surface. They can't exactly match the standard observer functions with filters while retaining adequate sensitivity for low light levels.[14] Thus, the accurate accuracy of filter colorimeters is considered inferior to scanning devices such as spectrophotometer. Spectrophotometers contain monochromators and photo diodes that measure the reflectance curve of a product's color every 10nm or less. In short, a colorimeter provides an overall measure of the light absorbed, while a spectrophotometer measures the light absorbed at varying wavelengths, because of the apparent advantages of spectrophotometer over colorimeter and visual method, color change in this study was measured using spectrophotometer.[15]

Debra. R. Haselton et al[13] investigated the color stability of methacrylate and bisacryl resin based Provisional restorative materials by dipping in coffee and artificial saliva. They concluded that fixed partial denture resins discolor over a range of time periods when immersed in coffee solutions. Several authors have found the same to be true in their study. Some of them include Stavros. A. Yannikanis et al (1998),[11] Ahmet Umut et al (2005),[16] Ahmet Umut et al (2005),[17] Jack. H. Koumjan et al (1991)[18] also found the discoloration of resins after 9 weeks in vivo, Karen. A. Achulze et al (2003)[19] found the color stability of chemical and light cured composites and the authors found that perceptible color difference could be observed after accelerated aging.

Bisacryl resins are two component materials based on multi functional methacrylic esters and fillers.[13] The results from this study can be attributed to the studies done by Bruce. J. Crispin(1979)[12] where he found that methacrylates are more color stable than bisacryl resins and coffee stained more as compared to other solutions, Debra. R. Haselton et al (2005),[13] Stavros. Yannikanis et al (1998)[11] where he concluded that tea exhibited least color changes.

Table 1: Mean and standard deviation of color stability values between four different provisional restorative materials with three types of beverages. (n=30)

Material/ Beverage		N	Max	Min	Mean	S.D	S.E
Structure 2SC	Control Coffee Tea	30	23.785	21.801	22.839	0.953	0.246
Protemp 4	Control Coffee Tea	30	24.005	18.764	21.036	1.430	0.347
Systemp c & b	Control Coffee Tea	30	24.709	18.168	21.699	2.498	0.606
Integrity	Control Coffee Tea	30	26.058	18744	21.186	1.962	0.476

Table 2: Mean and Standard Deviation of Color Stability values between three different beverages and provisional restorative materials (n=40)

Beverage/Material		n	Min	Max	Mean	S.D	S.E
Control	Integrity Protemp 4 Systemp c & b Structure 2 sc	40	18.464	26.058	23.078	3.242	1.621
Coffee	Integrity Protemp 4 Systemp c & b Structure 2sc	40	18.168	24.709	20.744	1.748	0.314
Tea	Integrity Protemp 4 Systemp c & b Structure 2sc	40	18.769	24.655	22.383	1.468	0.264

Table 3: Statistical comparison (two way ANOVA) of Color stability values between four different provisional restorative materials with three types beverages. (n=30)

Source	Degree of freedom	Sum of squares	Mean of squares	F-value	P-value	Remarks
Model	12	31078.498	2589.875	1266.518	0.000	S
Material	3	22.278	7.426	3.631	0.018	S
Beverage	2	49.980	24.990	12.221	0.000	S
Material and Beverage	6	46.592	7.765	3.797	0.003	S
Error	54	110.423	2.045			
Total	66	31188.921				

Color stability between the provisional restorative materials and between the beverages differed significantly at 5% level of significance ($p<0.05000$).

Table 4: Statistical comparison (Post-Hoc Test) of color stability values between different provisional restorative materials

Material (I)	Material (J)	Mean difference (I- J)	S.E	P-value	95% confidence interval for difference	
					Lower Bound	Upper Bound
Structure 2 sc	Protemp 4	1.803*	0.507	0.001	0.788	2.819
Structure 2 sc	Systemp c & b	1.140*	0.507	0.028	0.125	2.156
Structure 2 sc	Integrity	1.653*	0.507	0.002	0.638	2.669
Protemp 4	Systemp c & b	-0.663#	0.490	0.182	-1.646	0.320
Protemp 4	Integrity	-0.150#	0.490	0.761	-1.133	0.834
System c & b	Integrity	0.513#	0.490	0.300	-0.470	1.496

* Statistically significant ($p<0.05$)

\# Statistically not significant ($p>0.05$)

Color stability of structure 2SC differs significantly at 5% level of significance ($p<0.0500$) than other materials

Table 5: Statistical comparison (Post-Hoc Test) of color stability values between three different beverages

Beverage (I)	Beverage (J)	Mean difference (I-J)	S. E	P-value	95% confidence interval for difference	
					Lower Bound	Upper Bound
Coffee	Tea	-1.639*	0.363	0.000	-2.367	-0.910
Coffee	Control	-2.334*	0.760	0.003	-3.857	-0.811
Tea	Control	-0.695#	0.760	0.364	-2.218	0.828

*Statistically significant ($p<0.05$)

[#]Statistically not significant (p>0.05)

Color stability between coffee and tea, coffee and control differed significantly at 5% level of significance (p<0.05000) and color stability between tea and control was statistically not significant (p>0.05000).

Conclusion

Within the limits of this study and on the basis of results obtained it may be concluded that:

1. Coffee solution stains less than the Tea Solution.
2. Structure 2 Sc (Voco) displayed the more Color Stability and followed by system c & b and Integrity and protemp 4.
3. Combinations of Provisional Materials, Staining Solutions Are Significant Factors Affecting Color Stability.

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