To Compare and Evaluate the Colour Stability of Provisional Restorative Materials Exposed to Different Beverages at Varying Time Intervals - An in vitro Study

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Abstract: _Objectives_: *The purpose of this study was to evaluate the colour stability of provisional restorative materials exposed to different beverages at varying time intervals.* _Methodology_: *Forty samples of each materials (Protemp 4 and Revotek LC) were prepared with a diameter of 10mm and 3mm thickness. After immersion in staining solution of synthetic saliva (control), synthetic saliva and green tea,synthetic saliva and red wine, synthetic saliva and cold beverage; on 7th and 30th day color measurement was done using Spectrophotometer.* _Statistical analysis_: *Statistical analysis was done using Independent-t test and one way ANOVA.* _Result_: *Statistically significant color change was noticed in Red wine on comparing between Protemp 4 and Revotek LC provisional materials at the end of 7th and 30th day.* _Conclusion_: *Maximum discoloration was seen in synthetic saliva &red wine solution for all the two materials. Protemp 4 is the best material out of both, if provisional restoration has to given for longer duration in the esthetic region.*

Keywords: Provisional materials, Beverages, Colour stability

1. Introduction

Provisional restorations are used in fixed prosthodontics during period between tooth preparation and final prosthesis placement.[1] During this time span of fabrication of definitive prosthesis, which on an average takes about 7-30 days, prepared tooth need to be protected from the oral environment and also its relationship with the adjacent and opposite teeth need to be maintained. Thus, in order to protect these prepared abutment teeth, provisional restorations are fabricated and the process is called as Temporization.[2] The commonly used provisional restorative resins are polymethylmethacrylate (PMMA), poly ethyl methacrylate(PEMA),composite resin (bis-acryl composite) and poly urethane dimethacrylate. Regardless to composition and polymerization method, these materials tend to undergo colour changes and roughness over time due to the use of various staining beverages. This clinical situation can cause discomfort to the patient and result in dissatisfaction and distrust regarding the final treatment result. The oxidation of the polymer matrix and/or unreacted double bonds in the residual monomers causes this material to absorb pigments, thus resulting in different degrees of staining.[7]

There is a lack of information in few studies on the effect of different staining agents that can stain resin composite provisional restorative materials.[9] Hence, this study has been designed to evaluate the colour stability of two different commercially available provisional restorative materials when exposed to different beverages at varying time intervals.

2. Materials and Methodology

Two different provisional restorative materials (Protemp 4, Revotek LC) and test solutions (green tea, red wine and cold beverage) were used. 80 specimens were prepared in the form of discs of size 10 mm diameter and 3 mm thickness. A Teflon ring of 10 mm diameter and 3 mm depth were used for the preparation of samples. 40 samples, each of Protemp 4 belonging to group I and Revotek LC belonging to group II were then divided into four categories (A: synthetic saliva, B: synthetic saliva+ green tea, C: synthetic saliva+red wine, D: synthetic saliva +cold beverage). The 40 samples of each group were now separated into these four categories of 10 samples each as

- I ^{A}: protemp -synthetic saliva (n=10)
- I ^{B}: protemp- synthetic saliva+ green tea
- I ^{C}: protemp-synthetic saliva +red wine
- I ^{D}: protemp- synthetic saliva+ cold beverage
- II ^{A}: revotec-synthetic saliva
- II ^{B}: revotec - synthetic saliva+ green tea
- II ^{C}: revotec -synthetic saliva +red wine
- II ^{D}: revotec - synthetic saliva+ cold beverage

Test solutions were prepared by using synthetic saliva mixed with green tea, red wine and cold beverage. The 250 ml test solution of green tea and synthetic saliva were prepared in the ratio of 2:1. Green tea was prepared by using 150ml of

boiling distilled water with a tea bag, simmered for 5min and then filtered through a filter paper. Similarly, test solutions of red wine- synthetic saliva and cold beverage- synthetic saliva were prepared in the ratio of 2:1. A sample of 250 ml of synthetic saliva was taken as control.

Method of Staining

The samples were divided into two groups according to the test materials and four sub groups according to staining solutions. The colour measurements were made at baseline and at intervals of 1week and 4 weeks respectively after immersion in staining solution of synthetic saliva and Green tea for three times per day for ten minutes each, in synthetic saliva, Red wine and cold beverage for one time per day for ten minutes, in synthetic saliva and synthetic saliva (control) for whole day. The sample was rinsed with the distilled water and then gently cleaned with soft brush and then evaluated for colour change. The same procedure was followed subsequently for next immersion period. Solution was changed on every dipping.

Color of the specimens was measured using spectrophotometer against a white background using CIELAB color space relative to CIE standard illuminant D65. Color of specimens before immersion in the different types of beverages was measured according to the following formula:

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

ΔE = color change, L*= luminance reflectance, a* = red-green color coordinate, b* =yellow-blue color coordinate.

The same procedure were followed to evaluate the colour intensity of the remaining specimens after 1week and 4 weeks time interval.

3. Statistical Analysis

The data was collected coded and fed in SPSS (IBM version 23) for statistical analysis. The descriptive statistics included mean and standard deviation. The inferential statistics included independent t test and one way ANOVA. The level of significance was set at 0.05 at 95% confidence interval.

4. Results

The present in vitro study was conducted to compare and evaluate the colour stability of Protemp 4 and Revotek LC provisional restorative materials after exposure to Artificial Saliva (Control media), Green tea, Red wine, Cold drink at the end of 7 days and 30 days.

The overall colour change was recorded using Reflectance Spectrophotometer. The recorded values were statistically analysed using, Independent t-test and one way ANOVA. All statistical analysis were done using SPSS version 16 for Windows.

Table 1: Descriptive statistics showing color stability of Protemp 4 and Revotek LC at the end of 7th and 30th day.

			Mean	Standard deviation
A	Protemp 4	Baseline	.1270	.11691
		7th day	1.3620	.41774
		30th day	2.1440	.55903
	Revotek LC	Baseline	.0860	.04719
		7th day	1.6820	.50204
		30th day	2.9810	.34751
B	Protemp 4	Baseline	.1160	.07260
		7th day	1.6470	.65282
		30th day	3.3010	.46348
	Revotek LC	Baseline	.2790	.25440
		7th day	2.1830	.56631
		30th day	3.7450	.73387
C	Protemp 4	Baseline	.1820	.22135
		7th day	2.8360	.88105
		30th day	5.4630	2.46797
	Revotek LC	Baseline	.2450	.21640
		7th day	3.7620	1.10438
		30th day	9.8770	4.44664
D	Protemp 4	Baseline	.1010	.08425
		7th day	1.9860	.67802
		30th day	3.5140	.88066
	Revotek LC	Baseline	.1410	.12441
		7th day	3.5310	.78930
		30th day	7.5940	3.38393

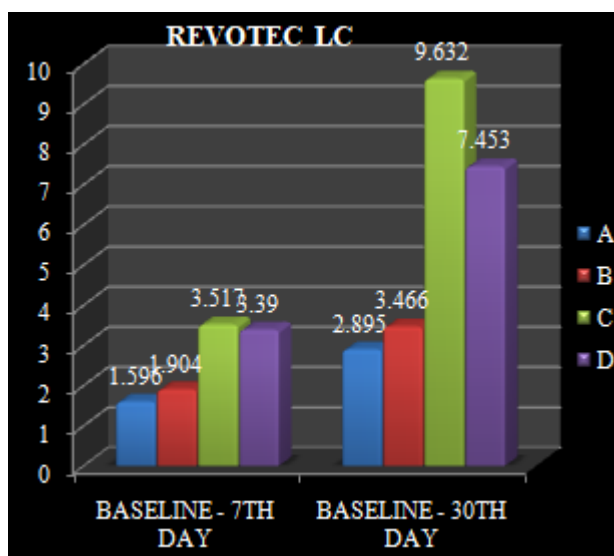**Table 2:** Comparison of color stability of various groups between Protemp 4 and Revotek LC on7th and 30th day

			Mean	Standard deviation	t	Significance
A	Baseline - 7th day	Protemp 4	1.2350	.42790	-1.1746	0.098 (N.S)
		Revotek LC	1.5960	.49417		
	Baseline - 30th day	Protemp 4	2.0170	.52806	-4.399	**0.000 (H.S)**
		Revotek LC	2.8950	.34578		
B	Baseline - 7th day	Protemp 4	1.5310	.65310	-1.347	0.195 (N.S)
		Revotek LC	1.9040	.58348		
	Baseline - 30th day	Protemp 4	3.1850	.45938	-1.152	0.264 (N.S)
		Revotek LC	3.4660	.61965		
C	Baseline - 7th day	Protemp 4	2.6540	.79329	-2.102	**0.049 (S)**
		Revotek LC	3.5170	1.02800		
	Baseline - 30th day	Protemp 4	5.2810	2.37631	-2.796	**0.012(S)**
		Revotek LC	9.6320	4.30990		
D	Baseline - 7th day	Protemp 4	1.8850	.62163	-4.814	**0.000(H.S)**
		Revotek LC	3.3900	.76877		
	Baseline - 30th day	Protemp 4	3.4130	.82777	-3.681	**0.002(H.S)**
		Revotek LC	7.4530	3.37084		

Table 3: Intergroup comparison of color stability between Protemp 4 and Revotek LC on 7th day and 30th day using one way ANOVA

			Mean	Standard deviation	F	Significance
Protemp 4	Baseline – 7th day	A	1.2350	.42790	9.232	0.000(H.S)
		B	1.5310	.65310		
		C	2.6540	.79329		
		D	1.8850	.62163		
	Baseline 30th day	A	2.0170	.52806	10.701	0.000(H.S)
		B	3.1850	.45938		
		C	5.2810	2.37631		
		D	3.4130	.82777		
Revotek LC	Baseline – 7th day	A	1.5960	.49417	17.663	0.000(H.S)
		B	1.9040	.58348		
		C	3.5170	1.02800		
		D	3.3900	.76877		
	Baseline – 30th day	A	2.8950	.34578	13.704	0.000(H.S)
		B	3.4660	.61965		
		C	9.6320	4.30990		
		D	7.4530	3.37084		
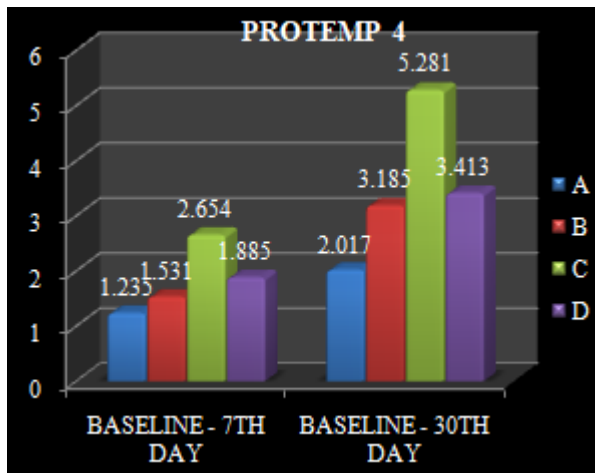
Graph 1: Multiple Bar diagram representing intergroup comparison of color stability of Protemp 4 on 7th day and 30th day

Graph 2: Multiple Bar diagram representing intergroup comparison of color stability of Revotec LC on 7th day and 30th day

5. Discussion

The prime concern of patients during any restorative procedure is esthetics and function. Provisional restorations are intended for the time between tooth preparation and before the fit and insertion of the final prosthesis. Along with restoration of function, colour stability of these provisional restorative materials also becomes an important consideration during prosthodontic rehabilitation when involving an esthetic zone or when intended to be worn for extended periods of time.[1,2]

The most routinely used group of material in the market is a group of bisacrylate composites. Comparable with composites routinely used for definitive restorations, these materials consist of an organic matrix and inorganic fillers. Monomers such as bisphenol-A-glycidyl methacrylate (bisGMA), triethylene glycol dimethacrylate or similar monomer systems derived from Bowen resin are also used.

Various studies have been documented in the literature on the colour stability of different provisional crown materials with numerous colouring agents. This study has been designed to significantly evaluate the colour stability of two commercially available provisional restorative materials in three different staining agents and also their difference at varying time intervals.

In the present study optimal polymerization was aimed in keeping with the suggestions made by the company that produces the provisional restorative material containing autopolymerizedBis-acryl. Polymerization was achieved between the glass plates with a view to reducing surface roughness. All the samples were prepared consistently with those of others studies regarding the colour stability of provisional restorative materials were standardized in such a way that each would have a thickness of 3×10mm. [1,6,10]

The highest color difference in this study was observed in the light-polymerized composite provisional material group (Revotek LC). Conversely, ΔE values for light-polymerized composite provisional material were significantly higher than the other materials tested after immersion in artificial saliva, green tea, red wine and cold drink. The discoloration might be due to both surface adsorption and absorption of colorants. Fine colorant particles may have deposited into the pits of the light-polymerized provisional material. Also, in the present study, the autopolymerising bisacryl composite (protemp 4) demonstrated significantly less color change than the other provisional material.

In the present study, the highest color difference in all of the composite materials was observed for the red wine groups. These results were in agreement with the previous studies whereby red wine caused most discolouration of provisional restorative materials. [6,8,14,26] The reason for this may be the sticky effect of sugar on the staining action.

Our study has evaluated that the colour stability of green tea can serve as substitute alternatives to standard ones. Green tea was found to cause less change in colour when compared to other beverages.[10]

One of the limitations of this study is that it is impossible to imitate the factors to be produced in the oral medium under the given experimental conditions. Another limitation is that the shape of the samples does not match those of eligible for clinical applications. The specimens were flat with ground surfaces, but, in a clinical situation, provisional restorations have an irregular shape with convex and concave surfaces.

6. Conclusion

Within the limitations of the study it was concluded that the:
1) The color stability of Protemp 4 after exposure to Artificial saliva (control media), Green tea, Red wine and cold drink (cola) at the end of 7 and 30 days showed highly statistical difference.
2) The color stability of Revotec LC after exposure to Artificial saliva (control media), Green tea, Red wine and cold drink (cola) at the end of 7 and 30 days showed highly statistical difference
3) Amongst the staining agents tested, red wine caused the greatest color change and Artificial saliva (control media) showed the least color change.

4) The comparison of color stability between Protemp 4 and Revotec LC after exposure to Artificial saliva (control media), Green tea, Red wine and cold drink (cola)at the end of 7 and 30 days showed highly statistical difference. The light polymerized composite, Revotec LC showed the lowest color stability when compared with auto polymerised composite, Protemp 4.

Figures

Figure 1: Beverages used in the study

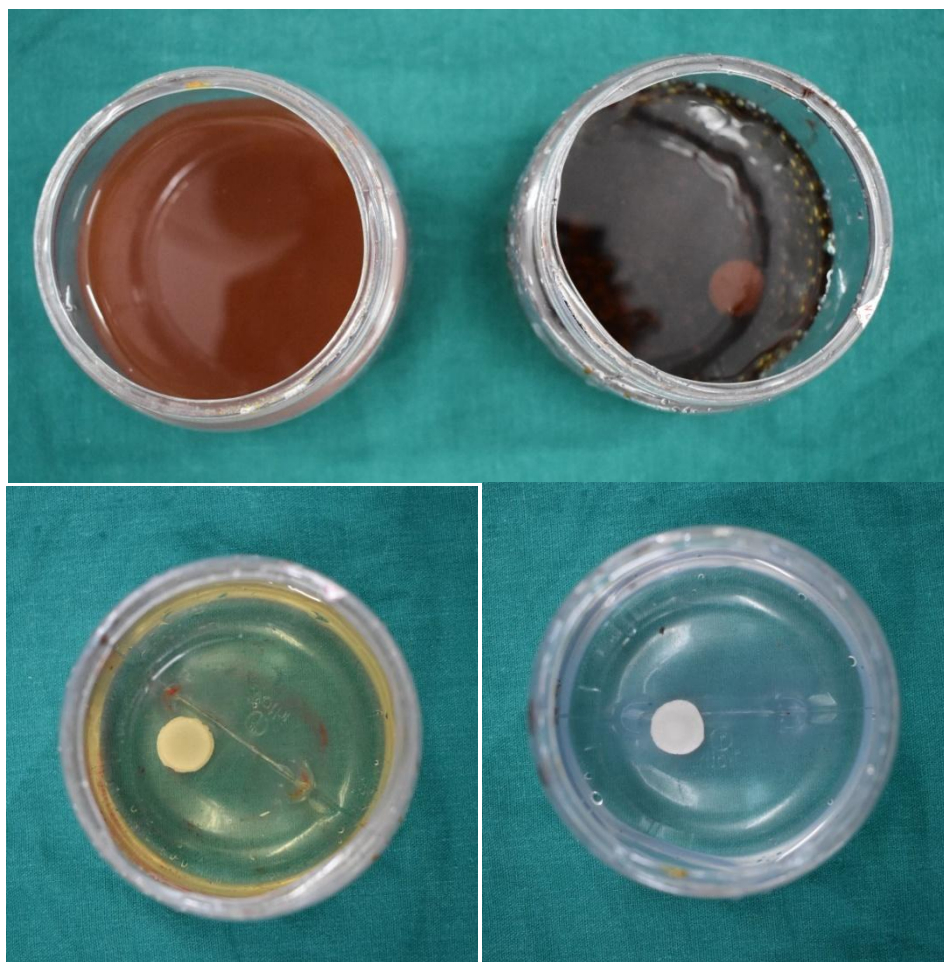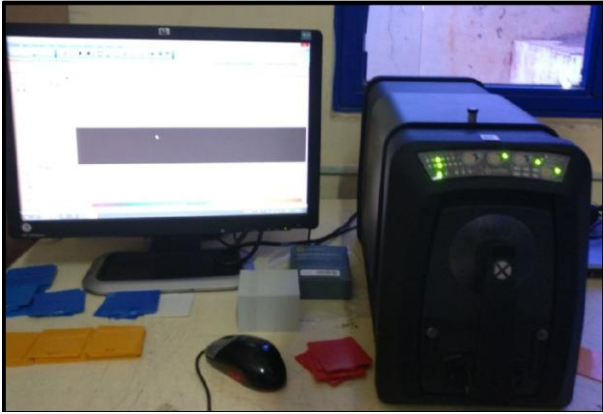**Figure 2:** Samples obtained after finishing and polishing

Figure 3: Beverages prepared for immersion

Figure 4: X Rite Spectrophotometer

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