

Color Stability in Temporization

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Abstract

Introduction Provisional restoration refers to a prosthesis which is designed to enhance the esthetic value, or function for a short time, following which it is replaced by using a fixed prosthesis. Color stability is very important factor to be kept in mind during selection of provisional materials in aesthetically important areas. Although there are various studies which look into the issue of stability of color of provisional restorations, the results are contradictory and confusing. This study was planned to compare the color stability of commonly used provisional restorative materials after exposing them to various kinds of discolorants.

Materials and Methods This work evaluated the effect of five common beverages, including tea, on color changes of different provisional materials: 1) Polymethyl methacrylates (DPI); 2) Bisacryl composite (ProtempTM II–3M ESPE); 3) Light polymerized composite (Revotek LC–GC). Color measurement of all specimens was compared with the original values of each specimen prior to immersion.

Results Within the limitations of this study, it was concluded that:

Keywords

- ▶ color stability
- ▶ Protemp
- ▶ Revotek

- a) There is no difference in color stability of provisional materials.
- b) Only food dye produced a clinically appreciable color change, whereas color change by cola and coffee cannot be appreciated by humans and that of tea can be appreciated only by trained eyes.

Introduction

Provisional restoration refers to a prosthesis which is designed to enhance the esthetic value for a short period, following which it is replaced by a fixed prosthesis. Provisional crown and bridge restorations serve many purposes including restoration of function, protection of the teeth and periodontal tissues, stabilization of the occlusion, and diagnostic evaluation prior to the fabrication of the final restoration.^{1,2} Their discoloration may result in dissatisfaction among patients and an extra cost for replacement.^{3–5} Hence, color stability is very important factor to be kept in mind during selection of provisional materials in aesthetically important areas. Several materials with different compositions are available for provisional restoration, but all these materials have shown the property of sorption (absorption and adsorption), due to which they are not color stable for longer duration. Although there are various studies which look into the issue of stability of color of provisional restorations,^{4,6} the results are contradictory and

confusing in nature. This study was planned to compare the color stability of the three most commonly used provisional restorative materials in clinical practice after exposing them to various kinds of beverages and food materials.

Materials and Methods

Provisional Materials

Manufacturers' instructions were followed to mix the materials under study:

1. Polymethyl methacrylates (DPI);
2. Bisacryl composite (ProtempTM II–3M ESPE);
3. Light polymerized composite (Revotek LC–GC).

After polymerization, gross trimming was conducted. They were subsequently polished using pumice and diamond polishing paste (YETI DENTAL) to make 25 resin discs each. Thus, a total of 75 discs of equal size (thickness = 3 mm, diameter = 20 mm) formed the study materials.



Preparation of Staining Solutions

1. The tea solution was prepared by dipping 1 tea bag (Taj Mahal, Hindustan Unilever Limited, India, 2 g) into 100 mL of boiling water for 10 minutes.
2. Coffee solution was prepared with commercially available instant coffee powder (Nescafe classic, Nestle India Limited, India) using 15 g coffee and 100 mL of distilled water.
3. For cola solution, commercially available brand of cola (Pepsi) was used.
4. A food dye solution was prepared by mixing 500 mg of food dye powder (in 100 mL of distilled water).

A 1:2 v/v mixture of staining solution and artificial saliva was made. The discs of each group were placed in the above-mentioned solutions for 25 days at 37°C which was changed every 5 days.

Color Measurements

CIE (Commission Internationale de l'Eclairage) $L^*a^*b^*$ scale, using reflectance spectrophotometer, was used for color measurements.

Baseline measurements were made after immersing the specimens in distilled water at 37°C for a period of 72 hours to eliminate residual monomers. Specimens were randomly divided into five groups ($n = 5$) and their color was measured (three readings per disc). After this, they were dipped at 37°C for 25 days in five different solutions and in a manner described earlier. Subsequently, the specimens were washed and color measurements done. The change in color (ΔE) was calculated.

Results

Mean values are shown in ►Table 1. Acquired data had to be transformed to show a normal and homogeneous distribution. Mean and standard deviation (SD) of this data are shown in ►Table 2. Two-way ANOVA and Tukey's tests were used as applicable for statistical evaluation. No statistical significance was seen when various provisional materials (DPI = PROTEMP = REVOTEK) were compared; however, there existed a statistical difference among solutions ($p < 0.05$). It was found that all solutions, except cola, differed from the control group. They also showed different characteristics when compared with each other. This allowed us to organize the means of transformed data in increasing order (water = cola < coffee < tea < food dye). A graph (►Fig. 1) was constructed to view the interaction between solutions and various provisional materials.

Table 1 Mean values of original ΔE data

Group	DPI	PROTEMP	REVOTEK
Water	0.75	0.85	0.53
Cola	0.81	0.85	0.95
Coffee	1.07	1.19	2.24
Tea	2.35	1.94	2.47
Food dye	3.79	3.29	3.97

Discussion

An ideal provisional restorative material must fulfill biological, mechanical, morphological, psychological, and esthetic requirements such as good marginal adaptation, retention and resistance to dislodgement during normal masticatory function, strength and durability, and being nonirritating, nonporous and dimensionally stable. It should also be comfortable, highly polished and highly color stable, maintain physiological contours, embrasures and occlusion, and easy to remove and replace by the dentist.^{7,8}

Provisional materials can be classified according to the type of resin.⁹ These are as follows:

- Polymethyl methacrylates.
- Bisacryl composites.
- Urethane dimethacrylates.

Polyethyl methacrylates are the oldest of all provisional materials. Bisacryl composites possess the advantages of lower curing temperature, reduced polymerization shrinkage, improved marginal fit, and better color stability. Urethane dimethacrylates have good mechanical properties, some control over its working time, and color is relatively stable but marginal fit can be poor.

In the present study, one material from each group is studied for its color stability in different staining solutions. According to our result, there exists no statistically significant difference in color stability of provisional materials.

Color stability can be evaluated visually and by instrumental techniques using spectrophotometer and colorimeter.¹⁰ Color perception is a psychophysical phenomenon and includes variation between individuals and within an individual at different times, so to eliminate such an error, instrumental technique is preferred.

Spectrophotometers contain monochromators and photodiodes that measure the reflectance curve of a product's color every 10 nm or less.¹¹ Therefore, spectrophotometers have been shown to be more accurate in measuring the color change than colorimeters, so in the present study, spectrophotometer was used.

Various studies have reported different thresholds of color difference above which the color change is perceptible to the human eye. We have used the National Bureau of Standards (NBS) classification for the same (►Table 4).^{12,13} Data was transformed by the formula $NBS \text{ unit} = \Delta E \times 0.92$.¹²⁻¹⁴ ►Table 3 shows the NBS units obtained this way.

Table 2 Mean values and SD of transformed ΔE data

Group	DPI	PROTEMP	REVOTEK	Mean
Water	0.93 (0.16)	0.98 (0.20)	0.80 (0.20)	0.90 (0.20)
Cola	0.96 (0.23)	0.98 (0.12)	1.02 (0.20)	0.98 (0.18)
Coffee	1.07 (0.16)	1.11 (0.09)	1.37 (0.23)	1.14 (0.18)
Tea	1.39 (0.10)	1.31 (0.12)	1.41 (0.12)	1.40 (0.12)
Food dye	1.59 (0.18)	1.53 (0.14)	1.61 (0.06)	1.60 (0.13)
Mean	1.19 (0.3)	1.18 (0.3)	1.24 (0.3)	

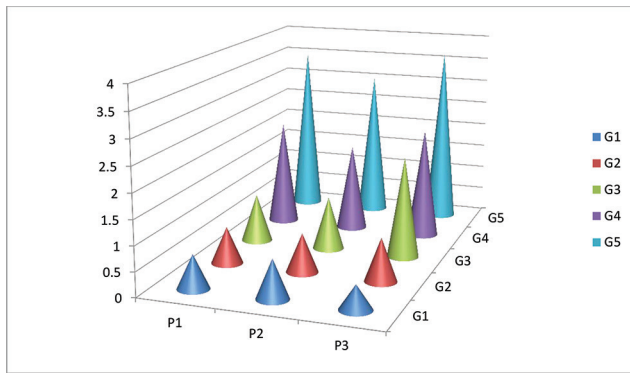


Fig. 1 Mean ΔE values according to solution and provisional materials. This figure shows that the color change produced by coffee was much higher in REVOTEK than in DPI and PROTEMP, which may indicate interaction between coffee and the REVOTEK.

Table 3 Means values of NBS units

Group	DPI	PROTEMP	REVOTEK	Mean
Water	0.69	0.79	0.49	0.66
Cola	0.75	0.79	0.88	0.81
Coffee	0.99	1.09	2.07	1.39
Tea	2.17	1.79	2.27	2.08
Food dye	3.49	3.03	3.66	3.39

Abbreviation: NBS, National Bureau of Standards.

The observations from this study and previous research¹⁵⁻¹⁸ show that the types of staining agent or exposure conditions are major factors that affect color stability of provisional restorative materials.

Pigments dissolved in water and other fluids that are consumed by the patients can get absorbed and adsorbed by the restorative materials and cause their color to change.^{12,19,20} This absorption occurs mostly due to the hydrophilic nature of polymethylmethacrylate (PMMA) and the porosity created while mixing.²¹⁻²³ Other possible reasons which can contribute to color instability are roughness of the surface, oxidation, dehydration, water absorption, and product degradation.^{12,21} In our study, all the provisional materials showed the same behavior regarding ΔE . The results of the Gupta et al.²⁴ showed that Revotek LC provisional restorative material was most color stable, followed by Protemp, Systemp and DPI. In a study conducted by Koumjian et al.,²⁵ an autopolymerizing methylmethacrylate resin (cold pack) was less color stable than bisacryl composite (Protemp), whereas Truekit and Duralay were more color stable. When comparing solutions, similar behavior was observed in cola and distilled water, with both classified as slight change rate according to NBS classification.^{12,13} Similar findings were reported by Guler et al.²⁶ Although coffee showed greater ΔE than cola and water, its mean value (1.14) as well as its NBS unit (1.39) was within the acceptable limit.²⁷⁻²⁹ However, it may be noted (► **Table 3**) that REVOTEK, dipped in coffee, had a mean value of 2.07, which is higher than 1.5 (perceivable as per NBS classification).^{12,13}

Table 4 NBS rating system for expressing color difference

NBS Units	Critical remarks on color difference
0.0–0.5	Extremely slight change
0.5–1.5	Slight change
1.5–3.0	Perceivable change
3.0–6.0	Marked change
6.0–12.0	Extremely marked change
> 12.0	Change to other color

Abbreviation: NBS, National Bureau of Standards.

Tea has a greater concentration of pigments in its solution. Our results are similar to the findings that tea has greater pigmentation potential than coffee^{20,30,31} but different from those of Imirzalioglu et al.,¹⁹ who found it to be insignificant. This can be explained by the kind of tea and differences in its processing before consumption. Food dye had the greatest ΔE of all the solutions tested, as found in others studies.^{17,21,30,32} Although our results seem to be similar to others, the clinical relevance of the beverages consumed shall vary with the consumption pattern and not only the type of beverages or foods consumed. More studies are needed to clarify this aspect.

Conclusion

Within the limitations of this study, it can be concluded that:

- There is no difference in color stability of provisional materials.
- Only food dye produced a clinically appreciable color change (3.39), whereas color change by soft drink (0.81) and coffee (1.39) turned out to be insignificant and that of tea (2.08) can be appreciated only by trained eyes.

However, it may be noted that consumption habits may ultimately change these findings.

Funding

None.

Conflict of Interest

None declared.

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