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Evaluating Color Stability of Three Different Provisional Crown Materials: A Short Study

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ABSTRACT

Purpose: To evaluate and compare the colour stability of three different provisional restorations using three different pigmented solutions

Material and Methods: Total six samples of each material for each group (Self-cure PMMA, Revotek LC, and CAD-CAM milled) with the following specifications 2mm occlusal reduction, 1.5 axial reduction, 1mm round chamfer finish line, 6° convergence angle. This prepared tooth will be used as a guide for the metal die. After immersion in a staining solution of synthetic saliva (control), synthetic saliva and tea, synthetic saliva, and turmeric, on the 1st, 7th and 30th-day color measurement was done using a Spectrophotometer.

Results: Mean values were compared using one-way analysis of variance (ANOVA) (statistically significant when $P < 0.05$). Post hoc test using Tukey's honestly significant difference was employed to identify significant groups (statistically significant when $P < 0.05$). Repeated measures of ANOVA were performed to analyze the color stability of the different specimens at different periods of storage. Significant groups were identified using the Bonferroni test.

Conclusion: Maximum discoloration was seen in synthetic saliva &turmeric solution for all the two materials. CAD-CAM is the best material out of both if the provisional restoration has to be given for a longer duration in the esthetic region.

INTRODUCTION

Provisional crown and bridge restorations serve many purposes in prosthodontic treatment, including restoration of function, protection of the teeth and periodontal tissues, stabilization of the occlusion, and as a diagnostic evaluation before the fabrication of the final restoration. (1)(2)

During this period of fabrication of definitive prosthesis, which on average takes about 7-30 days, the prepared tooth needs to be protected from the oral environment and also its relationship with the adjacent and opposite teeth needs to be maintained. Thus, to protect these prepared abutment teeth, provisional restorations are fabricated and the process is called Temporization. (3)

Although all these purposes are important, the esthetics of the provisional restoration is of prime importance to the patient, especially in cases of its usage for a long period and in the esthetic zone(4)(5).

The commonly used provisional restorative resins are polymethylmethacrylate (PMMA), poly ethyl methacrylate(PEMA), composite resin (bis-acryl composite), and polyurethane dimethacrylate.(6)

Regardless of the specific chemistry, most provisional restorative materials are subject to sorption resulting in color changes when subjected to various staining agents(2)(7) Several factors such as chemical and physical properties of the resin, incomplete polymerization, water sorption, chemical reactivity, diet (colorants in diet), oral hygiene, and surface roughness can affect color stability of these restorations. (8)(9) It is still a contentious issue in research as to which type of material has the better color stability (polymethyl methacrylates, polymethyl methacrylates, or bis-acryl composite resins). The degree of staining is affected by the duration of time the materials are exposed to the staining agents and their concentration. (10) Discoloration by tea is due to the adsorption of the polar colorants onto the surface of the restorative materials, whereas discoloration by coffee is due to both adsorption and absorption of the colorants into the restorative material(11)(12)

However, research has also demonstrated that there are resin composite materials of similar color stability.(13)(14)Seghi et al. (15) demonstrated that color measurement using a colorimeter provides consistent color evaluation. Colorimeters often report color using the CIELAB Color System, which is a method developed in 1978 by the Commission Internationale de l'éclairage for characterizing color based on human perception. It designates color according to three spatial coordinates, L*, a*, and b*, where L represents the brightness (value) of a shade, a* represents the amount of red-green color, and b* represents the amount of yellow-blue color. L* coordinates are located along a vertical axis that ranges from a value of 0 (blackest) to 100 (whitest). The a* and b* coordinates revolve on axes around L*. As a* becomes more positive in value, the color is more red; as a* becomes more negative in value, the color becomes more green. As b* becomes more positive in value, the color becomes more yellow; as b* becomes more negative in value, the color becomes more blue. Absolute measurements can be made in L*, a*, b* coordinates, and color change is calculated as ΔE. A ΔE value of 3.7 or less is considered to be clinically acceptable. The purpose of this investigation was to evaluate the color change of three temporary provisional crown and FPD materials after 1 day, 1 week, 15 days, and 1 month after immersion in artificial saliva, tea, coffee, and turmeric solutions.(16)

MATERIALS AND METHODS

This study was approved by the Institutional Review Board

A mandibular typodont (Nissin PRO2001-UL-SP-FEM-32, Kyoto, Japan) mandibular right first molar was prepared. The preparation was made following these specifications: 2 mm occlusal reduction, 1.5 mm axial reduction, 1mm round chamfer finish line, and 6° convergence angle. The prepared teeth were used as a guide for metal die fabrication all provisional restorative materials were mixed according to the manufacturers' instructions and placed in the mold. After polymerization, the specimens were grossly trimmed using blue-coded followed by red-coded tungsten carbides. Then, they were polished using pumice, followed by diamond polishing past

The staining solutions used were tea, turmeric and the control artificial saliva was prepared in the following concentrations:

Artificial saliva

It was prepared in the laboratory from 0.4 g sodium chloride (NaCl), 1.21 g potassium chloride (KCl), 0.78 g sodium dihydrogen phosphate dehydrate (NaH2PO4.2H2O), 0.005 g hydrated sodium sulfide (Na2S.9H2O), 0.005 g hydrated sodium sulfide (Na2S.9H2O), 1 g urea CO (NH2) 2, and 1000 ml of

deionized water. 10N sodium hydroxide was added to this mixture until the pH value was measured to be 6.75 + 0.15. It was then sterilized in the autoclave.[18

Table 1: Provisional materials

Product	Manufacturer	Material type	Shade
Self- cure tooth molding powder	DPI	PMMA	B1
CAD-CAM	DPI	pre polymerized PMMA	B1
Lightcure COMPOSITE RESIN	Revotec LC	UDMA	B1

Figure 1: Samples of 3 different commercial provisional material

- Tea solution About 2.8 g of tea was added to 150 ml of boiling distilled water.
- Turmeric solution About 0.5 g of turmeric was added to 150 ml of boiling distilled water

The samples were prepared and were divided into three groups of samples each (Group A = Self cure PMMA, B = CAM-CAM pre-polymerized PMMA, and C = light cure composite resin UDMA) which were subdivided into three subgroups (Subgroups A1, A2, A3; B1, B2, B3; C1, C2, C3,) according to the staining solution used. The staining solutions used were:

• Subgroup 1: Artificial saliva (660 ml) control
• Subgroup 2: A mixture of tea (330 ml) and artificial saliva (660 ml)
• Subgroup 3: A mixture of turmeric (330 ml) and artificial saliva (660 ml).

Figure 2: Samples immersed in coloring solutions

Specimens were immersed in their respective solutions at 37°C. The solution was changed every 3 days and stirred twice daily. Color measurements were made before immersion (T0), after 1 day (T1), 1 week (T2), and 1 month (T3). The specimens were rinsed with distilled water for 5 min and blotted dry with tissue paper before color measurement.

Color differences were measured by a reflectance spectrophotometer with the CIELAB system. Color difference (ΔE) was calculated from the mean ΔL*, Δa*, and Δb* values with the formula:

$\Delta E = ([L^*f - L^*i]\ 2 + [a^*f - a^*i]\ 2 + [b^*f - b^*i]\ 2)1/2$

Where the initial (i) and final (f) are color descriptors and L*, a*, and b * are differences in color parameters for the two specimens measured for comparison.

Figure 3: Spectrophotometer for analysis of color change at different time intervals

RESULTS

Mean values were compared using one-way analysis of variance (ANOVA) (statistically significant when $P < 0.05$). Post hoc test using Tukey's honestly significant difference was employed to identify significant groups (statistically significant when $P < 0.05$). Repeated measures ANOVA were performed to analyze the color stability of the different specimens at different time periods of storage. Significant groups were identified using the Bonferroni test.

DISCUSSION

The prime concern of patients during any restorative procedure is the esthetics of long-term provisional restorations used for extensive prosthodontic rehabilitation that need to be worn for a longer duration. Therefore along with the restoration of function, color stability of the provisional restorative materials also becomes an important consideration especially when involving the esthetic zone.(16)

Provisional crowns are typically fabricated from one of the available methyl or bisacryl resins. Regardless of their chemistry, dental polymers undergo a certain change in color over time. It can be due to food colorants, oral habits, drinks, or even mouth rinses/ mouthwashes.(8)(9)

The mechanism of staining could be explained by both absorption and adsorption of colorants. Numerous studies have reported that water sorption is influenced by factors such as filler content, the presence of residual unpolymerized monomers, the inclusion of air bubbles, and the cross-linking degree of resin molecules.(17)(18)(19)(20)

In particular incomplete polymerization might cause the physical properties of resin material to deteriorate and microleakage to increase thereby inducing color changes.(21)(22)

Various studies have been documented in the literature on the color stability of different provisional crown materials with coloring agents.(6)

This study has been designed to significantly evaluate the color stability of three commercially available provisional restorative materials in two different staining agents and also their differences at varying time intervals.

Discoloration can be evaluated visually and by instrumental techniques(spectrophotometer and colorimeter). Color perception by visual assessment is subjective and tends to vary from person to person due to factors such as illuminant position, the object being observed, color characteristics of the illuminant, fatigue, aging, metamerism, and also the environmental state

Spectrophotometers contain monochromators and photodiodes that measure the reflectance curve of a product's color every 10 nm or less. 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 a spectrophotometer over a colorimeter and visual method, color change in this study was measured using a spectrophotometer to potentially eliminate errors. The use of Commission International de L'Eclairage (CIE L*a*b*) uniform color scale has the advantage of having its arrangement in an approximately uniform three-dimensional color space.

Tea and turmeric can be identified as the most common staining substances and hence these staining solutions were used in this study.

The highest color difference in this study was observed in the light polymerized composite provisional material group (REVOTEK LC). The discoloration might be due to both surface adsorption and absorption of colorants. Fine colorant particles may have deposited into the pits of light polymerized provisional material.

Also in the present study, the CAD-CAM milled PMMA provisional crowns demonstrated significantly less color change than the other provisional materials. The reason for this is the manufacturing technique and fining of the final restoration which resulted in a smoother surface therefore making it more resistant to color change than the other two provisional materials.

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 small numbers of samples.

CONCLUSION

Color stability of there provisional restorative material was evaluated after 1 day, 1 week, and one month of immersion in artificial saliva, tea, and turmeric solutions, and the following conclusions were drawn:

1. At day 1 light cure composite (Revotec LC) showed the highest color change in turmeric followed by self-cure PMMA and CAD-CAM milled PMMA
2. After 1 week and 1 month of immersion in artificial saliva tea solution and turmeric solution. Light cure composite showed the highest color change compared to CAD-CAM milled and self-cure PMMA

The last color change was seen in CAD-CAM milled PMMA in both the staining solutions for all the time intervals

The color stability of CAM-CAM milled PMMA is highest followed by self-cure PMMA and then light cure composite

Among the 2 staining solutions turmeric shows a higher color difference than the tea solution

With the increase in the period, the color change also increased for all of the provisional materials in both the staining.

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