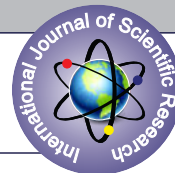


COMPARATIVE EVALUATION OF COLOUR STABILITY IN LABORATORY PROVISIONAL CROWN AND BRIDGE MATERIALS EXPOSED TO VARYING CONCENTRATIONS OF CHLORHEXIDINE GLUCONATE MOUTH RINSE AT DIFFERENT TIME INTERVALS: AN IN VITRO STUDY.



Prosthodontics

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ABSTRACT

Rehabilitations in fixed prosthodontics may require an extended period of provisionalization when additional therapy is required before completion of the treatment. Interim restorations in esthetically critical areas, should be able to maintain its esthetic appearance over the term of usage besides the initial shade match. This study evaluated the colour stability of laboratory provisional materials namely Cold/Self Cure Acrylic, Heat Cure Acrylic, CAD/CAM fabricated PMMA exposed to 0.2% and 0.12% Chlorhexidine gluconate staining solutions at different time periods using a Reflectance Spectrophotometer. Baseline colour measurement of all the materials were made. Fifteen samples each of SELF CURE PMMA, HEAT CURE PMMA, CAD/CAM PMMA were immersed in 0.2% and 0.12% CHX staining solutions respectively. After every 24 hours new mouth rinse solution was prepared and the specimens were taken out from previous solution and reimmersed in the new solution. Color variation of each groups were measured at the end of 2 weeks, 4 weeks, 6weeks. The result of the present study showed that there is significant difference in the colour of laboratory provisional materials in Chlorhexidine gluconate mouth rinse. Cold cure PMMA showed maximum colour variation from baseline colour measurement at the end of 6th week whereas Heat cure PMMA and CAD CAM PMMA showed better color stability.

KEYWORDS

Provisional restoration, Polymethyl methacrylate, Colour stability

INTRODUCTION

Esthetics in dentistry is concerned especially with the appearance of a dental restoration, as achieved through its colour and form. An insight into the science of dentistry along with an intimate knowledge of the different esthetic materials, their clinical indications, applications and limitations are a prerequisite for a successful practice.

Rehabilitations in fixed prosthodontics may require an extended period of provisionalization when additional therapy is required before completion of the treatment. In esthetically critical areas, provisional restorations should be able to maintain its esthetic appearance over the term of usage besides the initial shade match. Provisional restorations are exposed to varying pigments in the oral cavity. Staining of the same may result in patient discontent. Hence colour stability of the materials derives more attention in selecting particular provisional restorative material.^[1]

Polymethylmethacrylate [PMMA]^[2,3] has been in use for the fabrication of provisional restorative material since long. Heat cure and Self cure PMMA are our conventional material of choice for indirect or laboratory fabrication of provisional restorations. Recently, crosslinked PMMA blocks are milled to produce interim restorations using CAD/CAM technology. The superior physical and mechanical property of this material calls it for long term provisionalization.^[4] The durability and esthetics are the prime factors to be considered while making a choice between different materials. Colour stability of PMMA is a crucial factor in the selection of long term temporary restorative material.

Chlorhexidine gluconate is an effective antiseptic and safest anti-plaque agent and is indicated for use in the general population and in high risk groups of patients.^[5] Over the years, 0.2% and 0.12% CHX have been used extensively. In spite of the potent antimicrobial and antiplaque properties of Chlorhexidine, its use is limited by local side effects of which the main is the extrinsic staining of teeth and restorations. The amount of staining is more severe with higher concentration of the drug.^[6] Visual perception of colour change is subjective. A spectrophotometer gives quantitative evaluation of colour change which is repeatable, sensitive and objective.^[7,8]

This study aims to compare three differently manufactured Polymethylmethacrylate provisional restorative materials in terms of their colour stability in 0.2% and 0.12% Chlorhexidine gluconate solution after 2 weeks, 4 weeks and 6 weeks.

Methodology Study Groups

The following group of materials were evaluated at different time intervals of 2 weeks, 4 weeks, 6 weeks.

Group 1: Cold cure Acrylic [compression molded] + Synthetic saliva in A. 0.2% Chlorhexidine gluconate solution [n = 15] B. 0.12% Chlorhexidine gluconate solution [n = 15]

Group 2: Heat cure Acrylic [compression molded] + Synthetic saliva in A. 0.2% Chlorhexidine gluconate solution [n = 15] B. 0.12% Chlorhexidine gluconate solution [n = 15]

Group 3: CAD /CAM Fabricated PMMA + Synthetic saliva in A. 0.2% Chlorhexidine gluconate solution [n = 15] B. 0.12% Chlorhexidine gluconate solution [n = 15]

All the 90 specimens, were of size 10mm diameter and 2mm thickness with smooth, cleaned and polished surfaces. Cold cure PMMA and Heat cure PMMA specimens were fabricated by conventional compression molding technique. CAD CAM software [Trios] was used for the fabrication of CAD CAM PMMA specimens.



Figure 1: Finished Specimens Of Compression Molded Self-cure Pmma

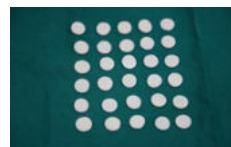


Figure 2: Finished Specimens Of Compression Molded Heat Cure Pmma

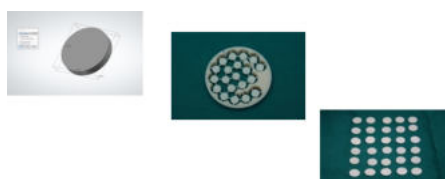
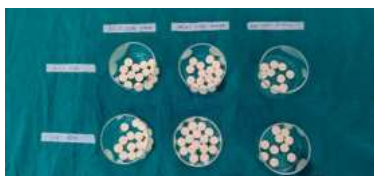


Figure 3: Finished Specimens Of Cad Cam Pmma

The staining solution was prepared by mixing 0.2% Chlorhexidine gluconate mouth rinse [Hexidine] and 0.12% Chlorhexidine gluconate mouth rinse [Hexidine EP] with synthetic saliva in 3 : 1 ratio [mouth rinse : synthetic saliva] respectively. [Synthetic saliva : Sodium chloride, Potassium chloride, Calcium chloride dehydrate, Sodium sulphide nonhydrate, Monosodium phosphate dehydrate, Urea]

15 samples each made up of COLD CURE PMMA, HEAT CURE PMMA, CAD/CAM PMMA were immersed in the 0.2% CHX gluconate and 0.12% CHX gluconate solution respectively at room temperature and were stored in a dark place to simulate oral conditions. Each sample was marked on the side opposite to the reading surface.

After every 24 hours new mouth rinse solution was prepared and the specimens were taken out from previous solution and re-immersed in the new solution.



Study Set Up

Colour measurements were done using a Reflection Spectrophotometer. The testing probe had a measuring aperture of 6 mm in diameter. The aperture of the probe was centered on the specimen to be measured. Before each measurement session, the Spectrophotometer was calibrated according to the manufacturer's recommendation by using the supplied white calibration standard A. Colour measurements (L^* , a^* , b^* , coordinates) of each specimen were taken at baseline (before immersion), and after 2 weeks, 4 weeks and 6 weeks. The specimens were rinsed with distilled water and blotted dry with tissue paper before colour measurement.

The L^* represented the values in lightness (black to white), a^* the values on the red-green coordinate, and b^* the values on the yellow-blue coordinate. The colour differences ΔE is

$$\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{1/2}$$

where ΔL , Δa , Δb , are the differences in L , a , b values before and after immersion at each time intervals (2 weeks, 4 weeks, 6 weeks). The ΔE value was given by the Spectrophotometer. After each session of colour measurements, the spectrophotometer was connected to a computer and the data retrieved and stored in an excel spreadsheet.

Based on the values obtained, data analysis was carried out using MS Excel and IBM SPSS statistics. Detailed statistical analysis was conducted on the respective samples using Analysis of Variance (ANOVA) and Post Hoc analysis. In this study $p \leq 0.05$ was considered as the level of significance.

RESULTS

This *in vitro* study evaluated the colour stability of Self cure, Heat cure and CAD CAM PMMA in 0.2% and 0.12% Chlorhexidine gluconate mouth rinse solution at 2, 4 and 6 weeks

The descriptive statistics table shows that at 2 weeks, the mean color difference between Self cure PMMA and Heat cure PMMA and Self cure PMMA and CAD CAM PMMA are significant with a p value less than 0.05 whereas the colour difference between Heat cure PMMA - CAD CAM PMMA is insignificant ($p = 0.82$)

At 4 weeks, the mean colour difference between Self cure PMMA and Heat cure PMMA and Self cure PMMA and CAD CAM PMMA are significant with a p value less than 0.05 whereas the colour difference between Heat cure PMMA and CAD CAM PMMA is insignificant ($p = 0.66$)

At 6 weeks, the mean colour difference between Self cure PMMA and Heat cure PMMA and Self cure PMMA and CAD CAM PMMA are significant with a p value less than 0.05 whereas the colour difference between Heat cure PMMA and CAD CAM PMMA is insignificant ($p = 0.75$)

Statistics show that Self cure PMMA is the least colour stable provisional restorative material in Chlorhexidine mouth rinse solution

at the end of 2, 4 and 6 weeks. The order of color stability in Chlorhexidine gluconate mouth rinse solution is CAD CAM PMMA $\geq$ HEAT CURE PMMA $>$ SELF CURE PMMA. It also shows that there is no significant colour change seen between HEAT CURE PMMA and CAD CAM PMMA

The study also showed significant colour difference between each time intervals. The maximum staining was found at the 6 week for all the materials thus showing a reduced color stability as the time of immersion advances.

The two concentrations of CHX (0.2% AND 0.12%) did not show significant difference in staining potential.

DISCUSSION

Esthetics has become the primary concern of all those who seek for a restorative procedure in their mouth. Colour of a restoration plays a major role in the esthetic outcome of a restorative treatment. Although provisional restorations are being used for a limited time period, color stability of the same is a major concern especially in esthetically critical areas and when it is worn for an extended period of time.

Dental polymers tend to change colour over time due to adsorption of liquids from the surrounding environment. The colour change could be caused by intrinsic and extrinsic factors. The intrinsic factors involve discoloration of the materials itself with alteration in its matrix. It occurs with aging as a result of physical-chemical conditions such as thermal and humidity changes. Extrinsic factors such as absorption and adsorption of stains may also cause discolouration. Various external factors like food colorants, drugs, oral habits can lead to discoloration. Mouth rinses which are commonly prescribed to patients for maintenance of a healthy environment can also be one factor for discoloration.^[9]

Heat cure and Cold cure Acrylics have been in use for fabrication of provisional restorations since 1930's. With the advanced technology and introduction computers into dentistry, CAD CAM milled PMMA blocks are available for provisional restorations. These offer improved accuracy, superior contour, exacting occlusion and better colour stability.

Numerous studies have been documented in the literature on the colour stability of different provisional materials. Koumjidn et al^[10], Gupta et al^[11] concluded from their study that autopolymerizing methylmethacrylate resins are less colour stable than other provisional restorative materials like bis - acryl composites whereas, Guler et al^[12], Yannikakis et al^[13], Crispin and Caputo^[14] concluded that PMMA has better colour stability than others.

Chlorhexidine gluconate is a broad spectrum antiseptic and is in use as an antiplaque agent for over a period of more than 30 years. Over the years, two concentrations namely 0.2% and 0.12% have been used extremely. However its use for a long period causes discoloration of teeth and restorations in the mouth.

This study evaluate the colour stability of three different laboratory provisional materials in chlorhexidine mouth rinses of 0.2% and 0.12% concentration.

In this study, immersion technique was used for staining the samples which doesnot exactly reflect the clinical reality. However, similar protocol was adopted in previous studies and was found adequate.

Visual colour perception is subjective and tends to vary from person to person. Using a spectrophotometer eliminate such errors and is used in this study for color measurement. Spectrophotometer gives the ΔE values which represents the colour difference before and after staining or between time periods.

Different studies reported different threshold values (ΔE) for visual perception of colour change. Values of ΔE between 0 to 2 were imperceptible, values from 2 to 3 were just perceptible, values from 3 to 8 were moderately perceptible and values above 8 were markedly perceptible.

The spectrophotometric values obtained in this study showed that there was significant difference in the color stability of laboratory provisional crown and bridge material in chlorhexidine mouth rinse

and thus it agree with our hypothesis.

On comparing the colour stability of Self cure PMMA with other two materials at 2, 4 and 6 weeks, there was significant difference noted ($p=0.00$). ΔE (mean colour change) was found to be maximum for Self cure PMMA ($p=0.00$) and minimum for CAD CAM PMMA. However there was no significant colour difference found between Heat cure PMMA and CAD CAM PMMA at any time intervals ($p = 0.85$ at 2 weeks, $p=0.66$ at 4 weeks and $p=0.75$ at 6 weeks).

Thus it can be concluded from this study that SELF CURE PMMA should be the least preferred provisional material in esthetically critical area when worn for a longer period of time. This result is similar to that obtained by Gupta^[11]

The colour change seen in Self cure PMMA may be due to higher water sorption property of the Self cure methacrylate resins. The non crystalline structure of polymethylmethacrylate possess high internal energy, as a result molecular diffusion into the resins can occur since less activation energy is required. The powder of Self cure PMMA contains peroxide (a chemical initiator), pigment and the liquid consist of a chemical activator (often tertiary amines) besides beads of methylmethacrylate. The presence of peroxide and oxidation of tertiary amines can lead to discoloration of Self cure PMMA materials. Moreover the higher resin content and porosity of the material can also be factor which contributes to discoloration. Heat cure PMMA exhibit greater strength, better wear resistance, colour stability and fracture resistance than the Self cure PMMA.

CAD CAM PMMA, the latest addition to the group of interim restorative material; are prepolymerized blocks of PMMA which shows higher monomer conversion and minimal preparation errors. Studies have proved that CAD CAM PMMA have better flexural strength than conventional PMMA's. The provisional restorations milled from these prepolymerized blocks of PMMA shows superior mechanical properties like reduced porosity and resin content, better colour stability, and increased strength. Thus it makes the best choice for long term provisionalization in esthetically critical areas.

The values from this study showed that the exposure time to the staining solution had a substantial impact on the colour stability. The ΔE values obtained at 6 weeks is greater followed by 4 weeks and 2 weeks. As established from the previous reports the smoothness and thickness of the specimen affect the colour stability of the materials. In this study, the thickness of provisional restorative material was standardized to 2mm.

In the present study the staining ability of 0.2% and 0.12% chx were also evaluated. Results of the study does not show any significant difference between the two. This was similar to the study conducted by shyamachandran et al to find the most efficacious strength of chlorhexidine used as a mouthwash while minimising the side effects.^[19]

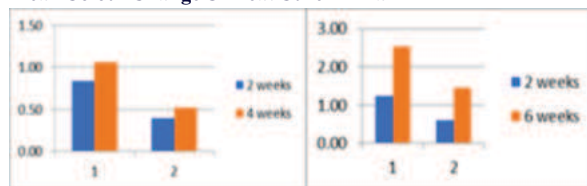
The limitation of the present study includes;

1. The fact that it is an *in vitro* investigation which could not fully simulate oral environment.
2. The specimen surfaces were regular and flat, whereas, clinically, provisional restorations will have an irregular shape with convex and concave surfaces
3. Mouth rinse solutions were used in this study to evaluate colour stability of the experimental materials; however, provisional materials may be exposed to various other food-staining substances in the oral environment
4. In the present study samples were immersed in mouth rinse solution for different time period. Time span of actual duration of contact during mouth rinsing protocols is to be considered. Further *in vivo* studies might be required for exact determination of color change in the oral environment.

Mean Colour Change Of Self Cure Pmma



Mean Colour Change Of Heat Cure Pmma



Mean Colour Change Of Cad Cam Pmma

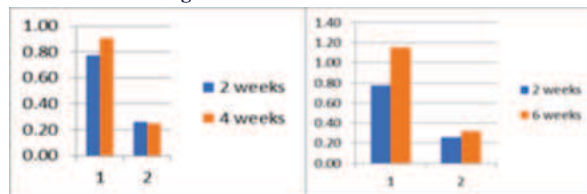


Table 1: Post Hoc Analysis to evaluate colour stability of each material at 2, 4 and 6 weeks

Multiple Comparisons							
Tukey HSD							
Dependent Variable	(I) group 1	(J) group 2	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
2 weeks	SELF CURE	HEAT CURE	.39667*	0.11	0.00	0.12	0.67
		CAD CAM	.46600*	0.11	0.00	0.19	0.74
	HEAT CURE	SELF CURE	-.39667*	0.11	0.00	-0.67	-0.12
		CAD CAM	0.07	0.11	0.82	-0.20	0.34
	CAD CAM	SELF CURE	-.46600*	0.11	0.00	-0.74	-0.19
		HEAT CURE	-0.07	0.11	0.82	-0.34	0.20
4 weeks	SELF CURE	HEAT CURE	.67167*	0.17	0.00	0.27	1.08
		CAD CAM	.81900*	0.17	0.00	0.41	1.22
	HEAT CURE	SELF CURE	-.67167*	0.17	0.00	-1.08	-0.27
		CAD CAM	0.15	0.17	0.66	-0.26	0.55
	CAD CAM	SELF CURE	-.81900*	0.17	0.00	-1.22	-0.41
		HEAT CURE	-0.15	0.17	0.66	-0.55	0.26
6 weeks	SELF CURE	HEAT CURE	1.21167*	0.23	0.00	0.65	1.77
		CAD CAM	1.37933*	0.23	0.00	0.82	1.94
	HEAT CURE	SELF CURE	-1.21167*	0.23	0.00	-1.77	-0.65
		CAD CAM	0.17	0.23	0.75	-0.39	0.73
	CAD CAM	SELF CURE	-1.37933*	0.23	0.00	-1.94	-0.82
		HEAT CURE	-0.17	0.23	0.75	-0.73	0.39

*. The mean difference is significant at the 0.05 level.

Clinical Implication Of This Study

PMMA resins are ideal long term laboratory provisional restorative material and were the first choice for many practitioners. With the advent of technology and introduction of CAD CAM in dentistry, a new variant of PMMA resins is been added to the conventional Cold cure and Heat cure variant. Chlorhexidine gluconate is well known for its antibacterial activity so is the most widely prescribed mouth rinse by the doctors on regular basis and also after extensive procedures in mouth. But Chlorhexidine is known to have a staining effect.

By this study we intend to find out the most color stable variant of PMMA resin in CHX gluconate mouth rinse and thus can be preferred in esthetically critical areas.

CONCLUSION

Within the limitations of the present study, it can be concluded that the CAD CAM PMMA offers better color stability in Chlorhexidine gluconate mouth rinse compared to other polymethylmethacrylate resins and thus is an ideal choice for long term provisionalization in esthetically critical areas.

Conflict Of Interest: Nil

Source Of Support : Nil

Ethical Support : Obtained

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