A COMPARATIVE EVALUATION OF MARGINAL ACCURACY AND COLOUR STABILITY OF PROVISIONAL RESTORATIONS FABRICATED FROM ONE COLD CURE ACRYLIC RESIN, TWO AUTOPOLYMERIZING RESINS AND ONE LIGHT CURE RESIN PROVISIONAL MATERIALS.

Dental Science

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ABSTRACT

The purpose of the present study was to evaluate and compare the marginal accuracy and color stability of four commercially available provisional restorative materials including one cold cure acrylic resin, two autopolymerized bis- acrylic composite resins and one light-cured composite resin.
Marginal discrepancy was measured by measuring the distance between the vertical reference line and crown margin of the restoration using a metallurgical microscope.
Marginal accuracy was found be in the following order.
Luxatemp >= Protemp IV > DPI > Revotek LC.
Forty disc specimens of 10 X 2 mm diameter each from cold cure acrylic resin, Protemp IV, Luxatemp, Revotek LC were fabricated to evaluate color stability in tea solution and artificial saliva.It was observed that there was least mean color change in the tea solution for cold cure acrylic resin.

KEYWORDS

marginal accuracy ,color stability , provisional restorative materials

Introduction

A Provisional restoration is a fixed or removable prosthesis, designed to enhance esthetics, stabilization and/or function for a limited period of time, after which it is to be replaced by a definitive prosthesis. (GPT-8)[1]

A provisional restoration is an important part of successful treatment for a fixed prosthesis. It must provide replacement of the lost or prepared tooth structure. Provisionals are used as diagnostic aids when correcting irregular occlusal plane, altering vertical dimension or planning for changes in the location and contour of the gingiva or the size, shape and color of the final restoration. The mean duration of use is seven to ten days, however clinical delay, disease, financial considerations etc may prolong the period in which a provisional restoration is in use and leads to substantial changes such as loss of strength, color, wear resistance,marginal fit, retention, and staining

Over the years various materials have been used for making provisional Over the years various materials have been used for making provisional restoration such as Polymethyl Methacrylate, Polyethyl Methacrylate, Polyvinyl Methacrylate, Bis-acrylic composite resin and Visible light-cured (VLC) Urethane dimethacrylate. [2] Historically acrylic materials have shown poor physical, mechanical and optical properties hence promoting the use of various composite resins. Composites have been introduced since the late 70's and have gained popularity due to recent advancements in their formulation with improved properties, esthetics and durability.[3] It is vitally important for provisional restoration to maintain a good marginal fit and color stability in the oral environment.

The aim of the present in vitro study was to evaluate and compare the properties of marginal integrity and color stability between four commercially available provisional restorative materials including one cold cure acrylic resin, two autopolymerized bis- acrylic composite resins and one light-cured composite resin.

Materials:

1. Metal die of prepared Ivorian maxillary central incisor with 1mm shoulder margin to receive provisional crown.
2. 4 provisional restorative materials all of A-2 shade.
   a. DPI-- (Group1) - Polymethylmethacrylate resin (Tooth colored)
   b. Protemp IV (Group 2) - Autopolymerizing bis-acrylic composite resin(3M-ESPE, St Paul, MN, USA)
   c. Luxatemp (Group 3) - Autopolymerizing bis-acrylic composite resin (DMG, Hamburg, Germany)
   d. Revotek LC (Group 4) - Light cure - Urethane dimethacrylate resin (GC India)
8. Optical microscope - Reichert Austria
9. Artificial saliva. (Fig 10)
10. Tea solution as the staining solution
11. Reflectance spectrophotometer

Method: For convenience, the methods for MARGINAL ACCURACY AND COLOR STABILITY are described separately

A] Marginal accuracy
A) Fabrication of metal die:
Metal die of prepared maxillary central incisor with 1mm shoulder was fabricated. 4 markings were scribed on the die. Each line was 1mm below the facial, lingual, mesial and distal margins of the die where the readings for marginal accuracy were made. V - shaped grooves one each on the mesial and distal surfaces of the metal die for orientation of the putty matrix during seating were made. Metal die was lubricated and wax pattern was fabricated on this die. Wax pattern was of the standard dimension of maxillary central incisor.

Figure 1: Metal die

B] Fabrication of matrix:
Putty index was made on the wax pattern that was prepared on the die. This index served as matrix for provisional restorations of the Cold Cure and autopolymerizing bis-acrylic composite resin group of

provisional materials. Vacuum former sheet of 0.5mm thickness was adapted on the stone model which served as clear template i.e matrix for curing of the light cure provisional material.

Figure 2: Adaptation of vacuum former sheet
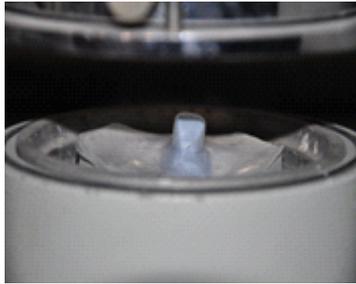
C] Fabrication of study samples:
For fabrication of samples, wax pattern was removed from the metal die. Die was the lubricated with petroleum jelly.

Table no.1:4 groups of 10 samples in each group were fabricated

| GROUP	BRAND	MANUFACTURER	MATERIAL TYPE
Group 1 10 samples	DPI	DPI	Cold cure-Polymethylmethacrylate resin
Group 2 10 samples	Protemp IV	3M ESPE	Bis-acrylic composite resin
Group 3 10 samples	Luxatemp	DMG	Bis-acrylic composite resin
Group 4 10 samples	Revotek LC	GC India	Light cure - Urethane dimethacrylate resin

D]Measuring marginal discrepancy:
Marginal discrepancy was measured at 4 vertical reference points at the midpoint of labial, lingual, mesial and distal surfaces. Marginal discrepancy was measured by measuring the distance between the vertical reference line and crown margin of the restoration using a metallurgical microscope (Reichert Austria) caliberated at 0.001mm at *100 original magnification. Measurements were made along the long axis of the die at each of these 4 reference points. Arithmatic mean of the 4 readings (f,l,m,d surfaces) was taken as marginal discrepancy value.

Figure 3:Metallurgical microscope (Reicherts' Austria)for measuring Marginal discrepancy

Figure 4:Measuring Marginal discrepancy on Metallurgical microscope
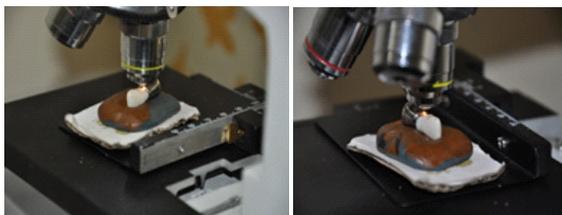
II) COLOR STABILITY
A]Fabrication of die:
For evaluating color stability, a metal mould comprising of six depressions, 2mm in depth and 10mm in diameter, arranged in two rows was fabricated. Forty Specimens, 10 in each group were fabricated by injecting the respective provisional material. Each specimen was finished and polished using the polishing kit.

B) Fabrication of disc samples:
4 groups of 10 samples in each group were fabricated as mentioned above.
Figure 5: Mould for fabrication of disc specimens for color stability

C] Tea solution preparation:
a. 500 ml distilled water was boiled in water steamer for 1 min and 45 secs. Tea bags were placed in it to prepare the tea solution.
b. After boiling, solution was filtered through filter paper and allowed to reach room temperature.
c. Tea solution was changed every 3 days.

D) Testing for color stability:
Figure 6:Reflectance Spectrophotometer for measuring color stability

Figure 7: Measuring color changes of samples on a Reflectance Spectrophotometer

Specimens in all the 4 groups were stored in distilled water for 24 hours at room temperature. The rehydration simulated the first day of service for provisional restorations in the oral environment. It is postulated that the materials will imbibe most of their water during the first day of immersion. After 24 hours, 5 out of 10 samples from each of the 4 groups were immersed in artificial saliva. The remaining 5 samples from each of the 4 groups were immersed in tea solution for evaluating their color stability.
Color measurements for the specimen disc were made as follows:
a. Just before immersion To
b. 1 day after immersion T1
c. 7 days after immersion T2
d. 30 days after immersion T3

Before each color measurement, disc were cleaned with distilled water for 5 mins and blotted on tissue paper. Color measurements were made on Reflectance spectrophotometer. Values were recorded according to CIE LAB system of the Reflectance spectrophotometer.

L*, a* and b* values of each specimen were recorded as T0,T1,T2,T3
3 measurements were taken for each specimen. Mean of these 3 reading was taken as ΔL* Δa* and Δb*

Color difference ΔE* was calculated from the mean for each specimen

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

Result:
A] Marginal discrepancy:
After applying multiple comparison test, it has been seen that, there is significant difference in the marginal fit of group 2 (luxatemp) over

3(Revotek LC) and 4 (DPI) groups. There was no significant difference in the marginal fit of group 2 (luxatemp) in comparison with group 1(ProtempIV). It has been observed that Luxatemp has marginal accuracy similar to Protemp IV, and better than DPI and Revotek LC. Marginal accuracy is in the following order.
Luxatemp >= Protemp IV > DPI > Revotek LC.

Table 2: Multiple comparison between all the 4 groups

			Mean Difference (I-J)	Std. Error	Sig.	95% Interval	Confidence
	(I) GR2	(J) GR2				Lower Bound	Upper Bound
Tukey HSD	1.00	2.00	1.3214	1.5610	.832	-2.9847	5.6275
		3.00	4.2957	1.5610	.051	-1.0394E-02	8.6018
		4.00	-1.1429	1.5610	.883	-5.4490	3.1633
	2.00	1.00	2.9743	1.5610	.252	-1.3318	7.2804
		3.00	-2.4643	1.5610	.409	-6.7704	1.8418
		4.00	-1.3214	1.5610	.832	-5.6275	2.9847
	3.00	1.00	-2.9743	1.5610	.252	-7.2804	1.3318
		2.00	-5.4386(*)	1.5610	.010	-9.7447	-1.1325
		4.00	-4.2957	1.5610	.051	-8.6018	1.039E-02
	4.00	1.00	2.4643	1.5610	.409	-1.8418	6.7704
		2.00	5.4386(*)	1.5610	.010	1.1325	9.7447
		3.00	1.1429	1.5610	.883	-3.1633	5.4490

Multiple Comparisons
Dependent Variable: GR1

B]Colour stability:
RESULTS: It shows that there was least mean color change in the tea solution for DPI from 0hrs to 24hrs to 7 days to 30 days followed by PROTEMP IV, LUXATEMP and REVOTEK LC.

It shows that there was least mean color change in the artificial saliva PROTEMP IV from 0hrs to 24hrs to 7 days to 30 days followed by LUXATEMP, DPI and REVOTEK LC.

Table 3: showing mean color changes of all the 4 groups from 0 hrs to 24hrs to 7ays to 30 days in tea solution and artificial saliva respectively.

Solution	Group	0 hrs	24 hrs	7th day	30th day	0- 24hrs	0-7day	0-30 day
Tea solution	Cold cure	85.61±0.50	81.79±0.84	81.01±0.76	78.26±0.80	3.81±1.01	4.59±1.06	7.74±0.182
	Protemp IV	81.79±1.29	76.36±1.19	76.81±0.88	73.44±0.48	4.97±1.36	5.42±1.59	8.35±1.58
	Luxatemp	77.60±0.94	73.62±0.76	68.72±0.86	68.10±1.02	3.982±0.77	8.88±0.71	9.5±1.74
	Revote LC	85.30±0.73	76.78±0.89	73.61±0.74	68.75±0.89	8.51±0.66	11.68±1.41	16.54±1.32
Artificial saliva	Cold cure	82.05±0.24	81.30±0.48	80.13±0.26	80.07±0.20	0.74±0.48	1.92±0.18	1.97±0.23
	Protemp IV	86.03±0.15	85.22±0.33	85.34±0.66	79.01±0.46	0.69±0.66	0.90±0.15	0.91±0.27
	Luxatemp	68.36±0.52	68.32±0.45	68.30±0.44	67.81±0.21	0.51±0.41	0.72±0.36	1.05±0.96
	Revotek LC	84.29±0.39	84.1±0.44	82.13±0.35	80.01±9.38	1.96±0.84	3.19±0.95	5.28±0.73

Discussion:
The provisional crowns in the present study were fabricated with indirect technique. The decision to use this technique was based primarily on the belief that this is most commonly employed method in practice. Potential errors were minimized by fabricating each crown on a metal die of ideal dimensions. Also, all the provisionals of the same brand were fabricated on the same day. This was done to achieve standardization of experimental conditions.

In the present study, all four materials used in the study exhibited some degree of marginal discrepancy. However, Revotek LC, a light cure provisional material exhibited the greatest discrepancy.

The study shows that there is significant difference in the marginal fit of luxatemp over Revotek LC and DPI. But, there was no significant difference in the marginal fit of luxatemp in comparison with ProtempIV. It has been observed that Luxatemp has marginal accuracy similar to Protemp IV, and better than DPI and Revotek LC. Marginal accuracy is in the following order Luxatemp >= Protemp IV > DPI > Revotek LC. This marginal accuracy is similar to results obtained by Edward J. Givens Jr et al in 2008.[4] They tested marginal fit and color stability of three provisional restorative materials and a control. Two auto-cure materials, Protemp Garant and Integrity, and one dual-cure material, Luxatemp Solar were used in their study. They concluded that the dual-cure temporary material (Luxatemp Solar) exhibited significantly more discrepancy at the margin than the auto-cure bis-acryl materials or acrylic control. A study showed that bis-acryl composite resin material was superior to PMMA because of its lower polymerization shrinkage and lack of exothermic reaction.[3]

Tea was used as the staining medium, as it has previously been found to be one of the strongest staining agents.[5,8] Also, tea is the most common beverage consumed in the Indian population. With very little exception, most of the samples in each group exhibited positive a* and b* changes in hue, or changes from a green/blue tone to a more red/yellow tone. Positive a* changes for all samples were much lower in magnitude than were positive b* changes. These findings are in agreement with another study that used tea as a staining medium and have been attributed to certain red and yellow polyphenolic chromogens.[6]

In the present study, 5 samples from each group were immersed in the tea solution for 30 days to find out which material has the best color stability. The remaining 5 samples were immersed in the artificial saliva to compare the color change.The measurements for color change for every sample were taken at 0hrs, 24hrs, 7 days and 30 days. The mean color change for DPI in the tea solution was the most stable compared to Protemp IV, Luxatemp and Revotek LC. The color change of Protemp IV was not significant when compared to Luxatemp. However, there was a highly significant color change seen in Revotek LC. The mean color change for Protemp IV in artificial saliva was the most stable compared to Luxatemp, DPI and Revotek LC. The color change of Protemp IV was not significant when compared to Luxatemp and DPI. However, there was a highly significant color change seen in Revotek LC.

This color changes are similar to results obtained by Arthur S. K. Sham et al 2004.[7] The color changes in their study for the water storage test showed that bisacryl methacrylate resins, Luxatemp and Integrity were

more color stable than methyl/ethyl methacrylate materials, Trim II, Alike, and Duralay. The more significant color change exhibited by the methyl/ethyl methacrylates in comparison to the bis-acryl methacrylate resins may be due to higher water sorption. Studies demonstrated lower water sorption for composite materials with high filler content (low resin content) compared with materials with lower filler content. Highly cross-linked resins were also shown to exhibit less water sorption.

CONCLUSION

Provisional materials exhibited different degrees of marginal adaptation. Similarly, Provisional materials exhibited different degrees of color change over a period of time in staining solutions. Within the limitations of the present study the following conclusions can be drawn:

1. Although the marginal accuracy of Luxatemp was the best of all the 4 provisional materials, there wasn't much difference in marginal accuracy of Luxatemp compared to Protemp IV and DPI. The marginal accuracy of these 3 materials is superior to Revotek LC.
2. Revotek LC had the least marginal accuracy.
3. Bis- acrylic composite resins and polymethyl methacrylate resins have superior marginal accuracy as compared to light cured resins.
4. DPI had the better color stability in tea solution as compared to Protemp IV,Luxatemp and Revotek LC.
5. The was no significant difference in the color stability of DPI, Protemp IV and Luxatemp.
6. The color stability of Protemp IV and Luxatemp was inferior to DPI but superior to Revotek LC in tea solution.
7. Revotek LC had the least color stability.
8. Polymethyl methacrylate resins and Bis- acrylic composite resins have superior color stability as compared to light cured resins.

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