

“Comparative Evaluation of the Effect of Three Polishing Agents on Staining Characteristics of Provisional Restorative Material:” An *in vitro* Study

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ABSTRACT

Aim: The present study aimed to evaluate the effect of three various polishing agents on provisional restorative material on immersion in a staining solutions.

Objectives: The objective of the study is (1) To evaluate the effect of pumice on staining characteristics of provisional restorative material before and after immersion in chlorhexidine. (2) To evaluate the effect of aluminum oxide paste on staining characteristics of provisional restorative material before and after immersion in chlorhexidine. (3) To evaluate the effect of diamond paste on staining characteristics of provisional restorative material before and after immersion in chlorhexidine. (4) To compare and assess the outcome of three polishing agents on staining characteristics of provisional restorative material.

Materials and Methods: Sixty samples (10 mm × 2 mm) were fabricated of bis-acryl composites (Protemp™ 4) by utilizing a metal mold. The samples were grouped into three groups ($n = 20$), and various polishing agents were used, including pumice, aluminum oxide paste, and diamond polishing paste. The samples that were not exposed to any polishing agent served as the control group. The samples were kept in a water bath for a day at 37°C and were stained with chlorhexidine mouthwash. The color of all specimens was measured with a spectrophotometer before and after polishing, and color changes (ΔE) were calculated.

Results: By using one-way ANOVA, significant difference was found in mean color change in three polishing materials ($F = 4.44$, $P = 0.016$). By using Tukey test, statistically significant difference was found among pumice and aluminum oxide paste ($P = 0.027$), among pumice and diamond paste ($P = 0.041$) and no significant difference was found among aluminum oxide paste and diamond paste ($P = 0.985$).

Conclusion: Pumice exhibited less staining which was statistically significant when compared with aluminum oxide paste and diamond paste. Hence, it can be considered the most efficient polishing agent.

KEYWORDS: Polishing material, provisional restorations, spectrophotometer

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INTRODUCTION

Provisional restorations are essential for successful prosthodontic therapy. The term provisional, interim, or transitional restorations should be used instead of the term temporary restoration which connotes laxity, and if this connotation becomes a philosophy of provisional phase of treatment, the dental surgeon will

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needlessly be reducing the clinical efficiency, treatment quality, and losing the confidence of the patient.

In practice, the provisional restorations can be used for several days or even more.^[1] The importance of providing interim treatment with provisional restorations becomes critical in cases of full mouth reconstruction, in which multiple teeth are prepared. The interim treatment focuses on protecting pulpal and periodontal health, promoting guided tissue healing to achieve an acceptable emergence profile, evaluating hygiene procedures, preventing migration of the abutments, providing an adequate occlusal scheme, and evaluating maxilla-mandibular relationships.^[2]

There are various materials available for the fabrication of provisional restorations. Acrylic resin materials such as polymethyl methacrylate resins, polyethyl methacrylate resins, or combinations of unfilled methacrylate resins have been used to fabricate provisional restorations. Other materials include composite provisional materials which are chemically comprised of a combination of two or more types of materials, bis-acryl resin, a hydrophobic material that is similar to bis- glycol methacrylates. Commercially available bis-acryl autopolymerized composite include Bis jet, Integrity Luxatemp, Protemp II, Protemp IV, Temphase, and Ultra Trim. Commercially available Bis-acryl composite (Dual-polymerized) are Iso temp, Luxatemp solar, and Provipont DC.

As a rule, the longer the material is exposed to various surrounding factors, the higher the chance for discoloration and material wear. Change in color of the temporary restorations leads to unsatisfaction of the patient adding to increased expenses due to the fabrication of new temporary restorations. Prolonged exposure of the temporary crowns to the staining agents because of the long duration of treatment leads to unesthetic situation. Various factors that affect the degree of change in the color of the prosthesis are incomplete polymerization, diet, oral hygiene, water sorption, chemical reactivity, and surface roughness. Different instruments such as spectrophotometer and colorimeters are used to remove the subjective bias.^[3] To limit potential discoloration process, to reduce gingival inflammation, and to minimize plaque adhesion, it is necessary to achieve a smooth surface of the restoration. For this, there are several polishing techniques available in the market such as polishing with pumice, diamond polishing paste, aluminum oxide polishing paste, Meisinger polishers, glaze, and bond varnish. As there are different recommendations given by different authors for their particular products regarding polishing techniques, it is very difficult to decide which polishing technique is the best for a specific material type.

The purpose of this study was to compare the effect of three polishing agents on staining characteristics of provisional restorative material.

MATERIALS AND METHODS

MATERIALS AND INSTRUMENTS

1. 3M ESPE Protemp™ 4 (A2 shade)
2. Three polishing agents: Pumice, Diamond Polishing Paste-DURA POLISH DIA 5 g (SHOFU INC), Aluminum Oxide Paste-DURA-POLISH 20 g (SHOFU INC)
3. Sensoseal-100 ml (Chlorhexidine Gluconate, Sodium Fluoride, and Zinc Chloride) mouthwash
4. Dental Impression Gun-Safe Plus with cartridge and acrylic C and B mixing tips (Safco)
5. Renfert Pleated Buff Nettle Cloth, High Shine, Pack 4 (2,100,002)
6. Sterile plastic containers
7. Polishing cone
8. Water bath
9. Color i7 Spectrophotometer
10. Custom Made Metal Mold.

METHODS

A cross-sectional study was performed over a period of 3 years from May 2015 to May 2018 at Sharad Pawar Dental College and Hospital after the ethical clearance from the Institutional Ethical Committee (DMIMS [DU]/IEC/2015-16/1546). The samples fabricated for the study was determined by using sample size formula with desired error of margin.

In this study, the provisional restorative material 3M ESPE Protemp™ 4 was investigated. The polishing materials used in this study were pumice, diamond polishing paste, and aluminum oxide paste [Figure 1]. Sixty cylindrical specimens (10 mm × 2 mm) were prepared for provisional restorative material tested using



Figure 1: Materials and instruments

a two-piece metal mold. Materials were manipulated as per the manufacturer's instructions. The samples included in the study were devoid of any defects. The samples with surface porosities, crazing, and malformed were excluded from the study [Figure 2]. The provisional restorative material samples were further grouped into three groups randomly by following the table of random numbers. Twenty provisional restorative samples were polished with pumice, 20 with aluminum oxide paste and 20 with diamond paste [Figure 3]. Polishing of the samples was done with Renfert Pleated Buff Nettle Cloth, High Shine, Pack 4.

Before polishing of the samples, baseline readings for all specimens were recorded using spectrophotometer in the form of $L^*a^*b^*$. Where L^* denotes lightness, a^* is red-green axis, and b^* is yellow-blue axis.

Samples were stored in water bath for 24 h at 37°C after recording baseline readings. Thereafter, the samples were stained with chlorhexidine mouthwash (Sensoseal-100 ml) [Figure 4]. After immersion for a day in chlorhexidine mouthwash, the samples were cleaned with distilled water for 5 min and were dried. Color readings were recorded in the same manner as baseline readings. ΔE^* for the baseline and after staining was calculated in the three dimensional. $L^*a^*b^*$ for color space was as follows. One-way ANOVA test was used to evaluate the effect of surface finishing procedure on color change. Tukey test was applied to compare the mean values.

Statistical analysis was done by using One-way ANOVA, Student's paired *t*-test and Multiple Comparison Tukey Test. The software used in the analysis was SPSS 17.0 (SPSS Inc., Chicago, IL), Epi info version 6 (Epi info, Atlanta, Georgia). Graph pad prism 5 version (EI Camio Real, San Diego, CA) and $P < 0.05$ is considered as the level of statistical significance.

RESULTS

The results of this study show that by using one-way ANOVA, significant difference was found in mean color change in three polishing materials ($F = 4.44$, $P = 0.016$). By using Tukey test, statistically significant difference was found between pumice and aluminum oxide paste ($P = 0.027$) and between pumice and diamond paste ($P = 0.041$). No significant difference was found between groups polished with aluminum oxide paste and diamond paste ($P = 0.985$).

DISCUSSION

In today's world, looking good is a primary concern. Beauty in health is the new mantra. The focus of dentistry in the present times is not only on the prevention and treatment but also on the demands for better esthetics

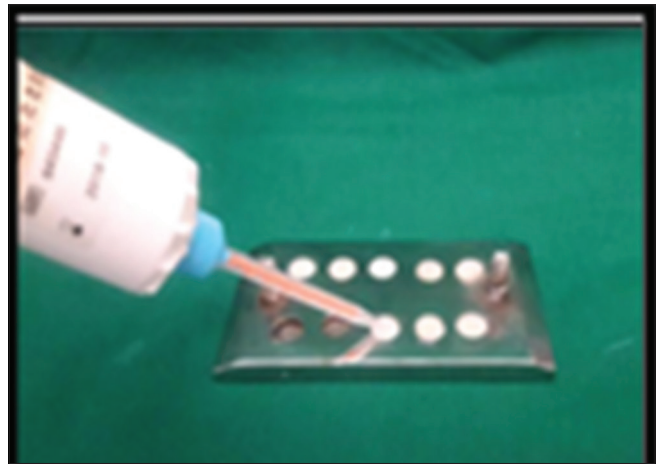


Figure 2: Dispensing of the material

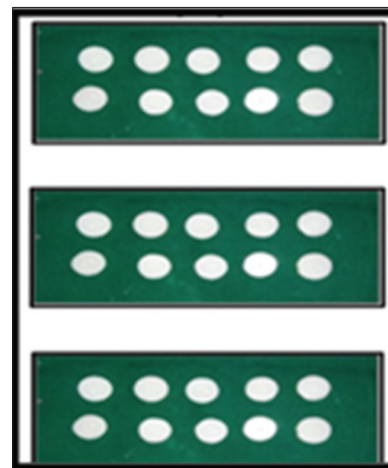


Figure 3: Sixty samples of 3M ESPE Protemp™ 4



Figure 4: Specimens immersed in sensoseal

and function of the restoration. The need for esthetically acceptable restoration with good dimensional stability and color stability has increased nowadays.

In 1999, Diaz-Arnold *et al.* in^[4] in his study stated that in choosing a provisional restorative resin material,

numerous factors are clinically desirable including dimensional stability during and after fabrication, adequate working time, ease of mix and repair, biocompatibility with the pulp and soft tissue, shade selection, and color stability.

In the present study, the effect of three polishing agents on staining of provisional restorative material was evaluated. As color perception is a psychophysical phenomenon with variations, both between individuals and within an individual at different times. Hence, instrumental measurement has the advantage of obviating the subjective errors of color assessment. The color measurements in the present study were carried out using a spectrophotometer. A spectrophotometer is scientific standardized colorimetric equipment for matching and measuring colors that give information about reflectance curve as a function of wavelengths in the entire visible range and thus numerically specifies the perceived

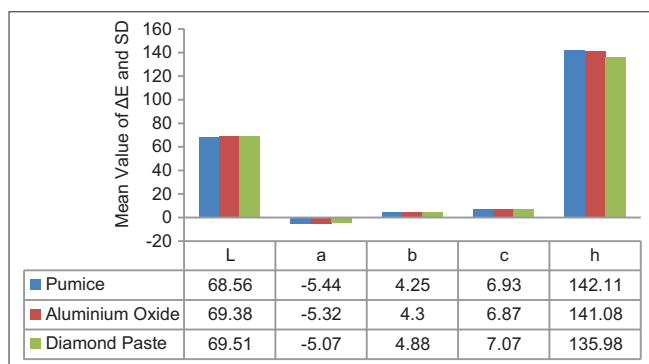
color of an object. The CIELAB measurements make it possible to evaluate the effect of polishing agents on staining of provisional restorative materials.

Readings were evaluated with the following equation:

$$\Delta E^* = ([L_1^* - L_0^*]^2 + [a_1^* - a_0^*]^2 + [b_1^* - b_0^*]^2)^{1/2}$$

The results of this study [Table 1] show that by using one-way ANOVA, significant difference was found in mean color change in three polishing materials ($F = 4.44, P = 0.016$). By using Tukey test, statistically significant difference was found between pumice and aluminum oxide paste ($P = 0.027$) and between pumice and diamond paste ($P = 0.041$) [Graph 1]. No significant difference was found between groups polished with aluminum oxide paste and diamond paste ($P = 0.985$). Ruyter *et al.* and Um and Ruyter, have given the upper limit of reliability in visual assessment. According to them, $\Delta E^* = 3.3$ can be taken as acceptable perceptible discoloration. It is documented that one CIELAB unit of color change is noticed by 50% of the human population. However, ΔE value more than 2 is always evident. Hence considering that a permissible color difference can be two to three times of noticeable limit. Color differences that is <3.7 CIELAB units is considered as clinically acceptable. For esthetic acceptability of the provisional restoration, a ΔE value of 3.7 is required.^[5] IAnd hence $\Delta E^*=3.7$ was taken as a criteria for acceptable or unacceptable, discoloration of the provisional restoration.

The ΔE values were also expressed as the National Bureau of Standards (NBS) units by the following formula to quantify the color changes according to this system: NBS



Graph 1: The comparison of L*a*b*c*h* values of three polishing agents on staining characteristics of provisional restorative material

Table 1: The comparison of mean color change (ΔE) of three polishing agents on staining characteristics of provisional restorative material

Descriptive statistics							
Material	n	Mean	SD	SE	95% CI for mean		
					Lower bound	Upper bound	
ΔE Pumice	20	1.85	0.40	0.09	1.66	2.04	
Aluminum Oxide Paste	20	2.33	0.75	0.16	1.98	2.69	
Diamond Paste	20	2.30	0.50	0.11	2.07	2.54	
One-way ANOVA							
Source of variation		Sum of squares	df	Mean square	F	P	
ΔE Between groups		2.92	2	1.46	4.44	0.016 (S)	
Within groups		18.75	57	0.32			
Total		21.67	59				
Multiple comparison: Tukey test							
Material		Mean difference	SE	P	95% CI		
					Lower bound	Upper bound	
ΔE Pumice	Aluminum Oxide Paste	0.48	0.18	0.027 (S)	0.04	0.91	
	Diamond Paste	0.45	0.18	0.041 (S)	0.01	0.88	
Aluminum Oxide Paste	Diamond Paste	0.03	0.18	0.985 (NS)	0.40	0.46	

SD=Standard deviation, CI=Confidence interval, SE=Standard error, S=Significant, NS=Not significant

unit = $\Delta E \times 0.92$.^[6] According to the NBS, the color change between 0.0 and 0.5 is marked as trace, 0.5–1.5 is slight, 1.5–3.0 is noticeable, 3.0–6.0 is appreciable, 6.0–12.0 is much and >12 is very much. By using above formula, NBS values in this study after polishing with pumice is 0.736, with aluminum oxide paste is 0.7544 and with diamond paste is 0.7912 [Table 2] suggestive of noticeable but clinically acceptable color change.

The results of this study show that the samples which were polished with pumice were the least stained and the samples with diamond paste were the most stained suggestive that pumice is the most efficient polishing agent as compared to the other three used. This study is in agreement with the study carried out in 2010 by Rutkunas *et al.*^[7] Who reported that the best combination between a provisional material and polishing technique was Unifast Trad and goat hair wheel with pumice powder as compared to aluminum oxide paste, polyresin, universal polishing paste. In 2017, Heath and Wilson.^[8] in their study reported that the least surface roughness was noticed for microhybrid composites subjected to finishing and polishing procedures with disk-shaped aluminum oxide-impregnated silicon points and felt disks using diamond paste or felt disks plus diamond paste. They justified that this could be because of the fineness of the flour of pumice which is a very finely grounded derivative while the diamond paste is a sort of polishing compound, which is made from finely ground or powdered diamond particles and some liquid, generally water based. In 2007, Uçtaşı *et al.*^[9] in his study showed that mylar matrix strip produced a smoother surface than Sof-Lex and Po-Go discs. Furthermore, Sof-Lex discs provided smoother surfaces than Po-Go discs for microfill, hybrid, and packable composite resin materials. This is in agreement with the results which were found in this study that, aluminum oxide paste produced smoother surface than diamond paste. This could be because pumice and aluminum oxide paste has fine abrasive particles compared to diamond. The size and geometry of particles exert a direct impact on the surface smoothness and staining resistance. The combination of nanofillers in nanocluster formulations reduces the interstitial space among fillers, increasing the filler percentage and improving the physical properties.^[10] Thereby having

effect on surface smoothness, in accordance to the study in 2015 by Madhyastha *et al.*,^[11] the present study also observed less staining of samples polished with aluminum oxide paste compared to diamond paste. In a study carried by Tupinambá *et al.* in 2019 goat hair brush with diamond paste was the most effective polishing system for acrylic and bisacrylic resins.^[12]

The surface of a provisional restoration has to be as smooth as possible. The surface of provisional restoration should be smooth so as to ensure long term esthetics. The wear due to finishing polishing also affects the color stability of the prosthesis. For these reasons, sufficient finishing and later polishing are ways to fortifying a restoration against plaque accumulation, possible adsorption of stains, and increased material wear which could compromise the clinical performance of the whole restoration.^[11] Discoloration of provisional restorative materials for fixed prosthodontics may lead to patient dissatisfaction and additional expense for replacement. This is particularly problematic when provisional restorations are subjected to prolonged exposure to colorants during lengthy treatment. The degree of color change can be affected by a number of factors, including incomplete polymerization, water sorption, chemical reactivity, oral hygiene, and surface smoothness of the restoration. Saliva, food components, different drinks, beverages, and mouthrinses may also affect the color of provisional restorations. There are varieties of mouthrinses available. Mouthrinse factors that can affect the color stability of provisional resins are two, namely composition of the mouthrinse and coloring material incorporated in the mouthrinse.^[5] In 2013, Turgut *et al.*^[13] in their study found that there were no significant differences between the discoloration effects of alcohol containing mouthwash, chlorhexidine, benzydamine HCl, or the benzydamine HCl and chlorhexidine mixture on the provisional materials. Chlorhexidine gluconate mouthrinse (Sensoseal - 100 mL) is a cationic oral antiseptic agent with bactericidal activity and acts by destabilizing and penetrating in bacterial cell membranes. It has been broadly used because of its antiseptic and antimicrobial effects against oral and dental diseases.^[5] Considering the easy availability and wide usage, chlorhexidine gluconate mouthrinse was chosen for this study.

The present study demonstrated that finishing of the provisional restorations should be done with the finest polishing agents available and which retains less stain. Thus, the results of this *in vitro* study suggest that pumice is the most efficient polishing agent and retains less stain as compared to aluminum oxide and diamond paste.

Since this is an *in vitro* study the contours of the crown was not followed that might alter the results. Similarly,

Table 2: The National Bureau of Standards values of pumice, aluminum oxide paste, and diamond paste

Polishing pastes	NBS values	
	ΔE values	NBS values
Pumice	1.85	1.702
Aluminum Oxide Paste	2.33	2.143
Diamond Paste	2.3	2.116

NBS unit = $\Delta E \times 0.92$. NBS= National Bureau of Standards

the restorations in the oral cavity are exposed to diverse conditions which also affect the surface texture of the restoration that is missing in the current study.

Further studies can be carried out to evaluate the influence of thermal cycling, abrasion and surface roughness on the degree of total color change. More comprehensive strategy should be developed to test the oral environment influences on the color stability of provisional prosthetic materials.

The present study demonstrated that finishing of the provisional restorations should be done with the most fine polishing agents available and which retains less stain. Thus, the results of this *in vitro* study suggest that pumice is the most efficient polishing agent.

The effectiveness of the polishing agent is only one of the variables that must be considered when choosing provisional material; it is of great importance to patients and clinicians when working especially in esthetic zone.

CONCLUSION

The color change of a commercially available provisional restorative material was evaluated after polishing with polishing agents and immersion in chlorhexidine mouthrinses. ΔE value obtained after polishing with pumice was 1.85, with aluminum oxide paste was 2.33, and with diamond paste was 2.3 [Table 1 and Graph 2].

Within the limitations of this study following conclusions can be drawn:

- Pumice exhibited less staining which was statistically significant when compared with aluminum oxide paste and diamond paste. Hence, it can be considered the most efficient polishing agent
- Diamond paste is the least efficient polishing agent
- Aluminum oxide paste has the intermediate efficiency in removing stains when compared with pumice and diamond paste.

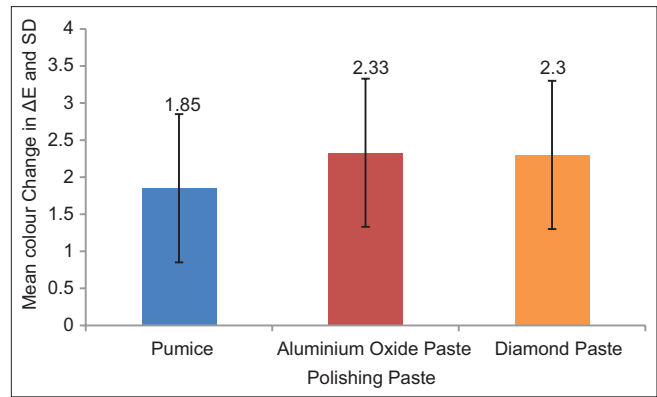
Although the effectiveness of the polishing agent is only one of the variables that must be considered when choosing provisional material, it is of great importance to patients and clinicians when working especially in esthetic zone.

FINANCIAL SUPPORT AND SPONSORSHIP

Nil.

CONFLICTS OF INTEREST

There are no conflicts of interest.



Graph 2: The comparison of mean color change (ΔE) of three polishing agents on staining characteristics of provisional restorative material

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