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Comparative Evaluation Of The Staining Effect Of Chlorhexidine And Octenidine Mouthwashes On 3m Provisional Restorative Material: An In Vitro Study

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Abstract

Background: Provisional restorative materials play a crucial role in maintaining function and aesthetics during interim dental treatments. However, their exposure to commonly prescribed antiseptic mouthwashes may lead to discoloration.

Aim: To evaluate and compare the staining effect of Chlorhexidine and Octenidine mouthwashes on 3M bis-acryl provisional restorative material.

Materials and Methods: Twelve standardized disc-shaped samples of 3M bis-acryl composite were fabricated and divided into two groups (n=6). Group A was immersed in chlorhexidine mouthwash, while Group B was immersed in octenidine mouthwash. Color measurements were recorded at baseline, 12 hours, and 24 hours using a spectrophotometer. Color change (ΔE) values were calculated and statistically analyzed.

Results: Both groups exhibited color changes over time. However, the chlorhexidine group demonstrated significantly higher ΔE values compared to the octenidine group, particularly at 24 hours.

Conclusion: Chlorhexidine mouthwash causes greater staining of 3M provisional restorative material compared to octenidine. Octenidine may be preferred in cases where aesthetic preservation is critical.

Keywords: Chlorhexidine, Octenidine, 3M, Provisional restorations, Color stability, Bis-acryl composite

Introduction

Fixed prosthodontic therapy involves the replacement and restoration of missing or damaged teeth using artificial substitutes that are permanently cemented or bonded in place. It aims to restore oral function, improve aesthetics, and maintain the integrity of the dental arch. Over time, the scope of fixed prosthodontics has expanded beyond simple tooth replacement to include occlusal rehabilitation, management of temporomandibular disorders, stabilization of weakened teeth, and enhancement of overall aesthetics.

Fixed prostheses such as crowns, inlays, bridges, onlays, and implant-supported restorations not only restore function but also influence facial appearance and patient confidence.

Provisional crown and bridge restorations are defined as “an interim dental prosthesis that maintains function, protects the teeth and periodontal tissues, establishes occlusion and serves as a diagnostic evaluation prior to fabricating the final restoration as regard esthetics”.

Interim (provisional) restorations play a critical role in the success of fixed prosthodontic treatment. They provide temporary restoration of function, aesthetics, and comfort between tooth preparation and placement of the definitive prosthesis.

Provisional restorations also serve as valuable diagnostic tools. They allow clinicians to evaluate occlusion, aesthetics, phonetics, and overall design before finalizing the definitive prosthesis. Necessary modifications can be made at this stage, minimizing complications and improving treatment outcomes.

In endodontically treated teeth, provisional restorations are even more critical, as they help maintain the coronal seal and prevent reinfection of the root canal system. Loss of this seal can lead to microleakage, bacterial contamination, and eventual treatment failure. The use of a temporary luting agent also supports this protective layer, giving a good but removable seal and easy removal when the time comes to cement the final prosthesis.

In complex and long-term treatments such as full-mouth rehabilitation or multidisciplinary procedures, provisional restorations help maintain periodontal health and stability. They protect gingival tissues, preserve biologic width, and guide soft tissue healing and contouring, particularly in aesthetic regions.

Color stability is an important factor in the success of provisional restorations. Discoloration or staining can compromise aesthetics, particularly during long-term treatments. Provisional restorations may remain in the oral cavity for extended periods, making resistance to staining an important property. Discoloration can negatively affect patient perception and may require replacement, increasing treatment time and cost.

Traditionally, methyl methacrylate-based acrylic resins were used for provisional restorations. However, newer materials such bis-acryl composites offer improved mechanical properties, handling, and aesthetics. Among these, bis-acryl composites are widely used due to their ease of manipulation, good polishability, and acceptable color stability.

Discoloration of provisional materials can occur in three forms: External, surface/Subsurface and Intrinsic. External discoloration results from plaque accumulation and surface stains. Surface or subsurface discoloration occurs due to adsorption of staining agents, while intrinsic discoloration results from chemical changes within the material. . It is important to choose provisional materials that allow for colour stability and resistance to staining.

Pre-emptively, regular follow-ups can aid with these issues. When properly placed, Provisionals can maintain form and function until the final prosthesis.

It also is important to understand that although provisional restorations are fabricated after tooth preparation, their design is carefully planned from a diagnostic wax-up on the mounted diagnostic casts, which is completed well in advance of tooth preparation or removal of previous restorations.

A critical step in fabricating intracoronal and extracoronal restorations is the placement of provisional restorations that restore function, provide stabilization, protect tooth structure and surrounding soft tissue, and promote prriodontal health and architectural form.

Many of the requirements such as appropriate marginal adaptation, low thermal conductivity, non-irritating reaction to the dental pulp and gingival tissues, ease of cleaning, ease of contour, and ease of alterability and repair are extremely important to the success or failure of treatment outcomes.6

A definitive marginal seal also promotes optimal periodontal and gingival health and facilitates the impression and cementation procedures and maintenance of the gingival architecture7

Several factors influence color stability, including material composition, degree of polymerization, water sorption, chemical reactivity, dietary habits, and surface roughness. Materials with incomplete polymerization contain unreacted monomers, that can increase chances of staining. Water sorption also plays an important role, as absorbed fluids can carry pigments into the material.

Evaluation of color stability can be performed visually or using instrumental methods. Visual assessment is subjective and influenced by factors such as lighting conditions and observer perception. Instrumental methods, such as spectrophotometry, provide objective, precise, and reproducible measurements using standardized color systems like CIE Lab*. These methods are particularly valuable in research settings for detecting even minor color changes.

Materials And Methods

This in vitro experimental study was conducted to evaluate the staining potential of two mouthwashes on 3M provisional restorative material

Figure 1. 3M Provisional Restorative Material (Bis acryl composite)

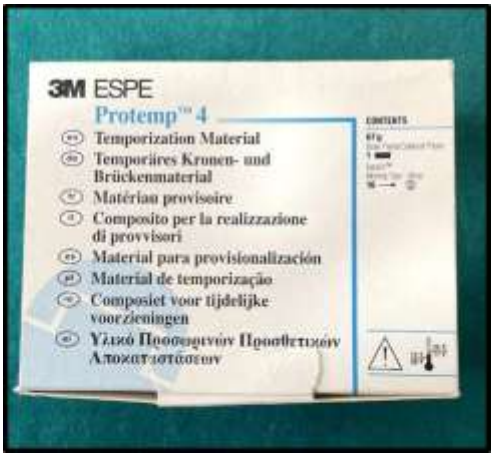

Figure 2. Specimen prepared from restorative material

Table 1: Materials used in the study

Commercial name	Composition	Dispensing system	Polymerization	Shade	Manufacturer
3M	Bis-acryl composite resin	Base & catalyst	Chemically cure	A2	3M ESPE

The present study includes a total of 12 samples were fabricated from each of the provisional restorative materials under consideration.

There were 12 discs measuring 3.5 cm in diameter and 1.5 mm in thickness and thus maintains that common dimension across materials.

All the materials in the study were selected in the same baseline shade of A2 in order to maintain standardization in colour for valid comparative analysis.

ΔE was determined for each specimen by the difference in colour after immersion in the respective staining solutions against the baseline (pre-immersion) shade. This allows a reliable measure of colour stability.

For preparing specimens, a rubber ring mould with an internal diameter of 3.5 cm and 1.5 mm height was used.

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Color Change Calculation:

Table 2: Critical marks of color difference according to the National Bureau of Standards (NBS)

NBS unit	Critical marks of colour Difference	Definitions of colour difference
0.0-0.5	'Trace'	Extremely Slight change
0.5-1.5	'Slight'	Slight change
1.5-3.0	'Noticeable'	Perceivable change
3.0-6.0	'Appreciable'	marked change
6.0-12.0	'Much'	Extremely marked Change
>12.0	'Very much'	Change to other colour

For preparation of samples for bis-acryl composite (3M), the material is dosed and statically mixed in the dispenser gun. The material is dispensed via original mixing tips and loaded in the mold over the glass plate. Then another glass plate is then gently placed over it and the sample is retrieved after the material gets set.

All the specimens were then placed in a controlled environment (temperature and humidity) until the completion of polymerization. After polymerization, all specimens were examined visually for any porosity, surface consistency, and uniformity of thickness to ensure quality and standardization. The consistency of the testing surface was also observed to assess complete polymerization. The samples were stored in a controlled environment.

Polishing Of Samples

The samples from bis-acryl composite (3M) material were cleaned with ethanol and then finished and polished according to manufacturer's instructions.

Experimental Groups

All 12 specimens were stored in distilled water at room temperature for 24 hours in plastic containers. The 12 specimens were randomly divided into 2 groups of 6 specimen each.

Grouping:

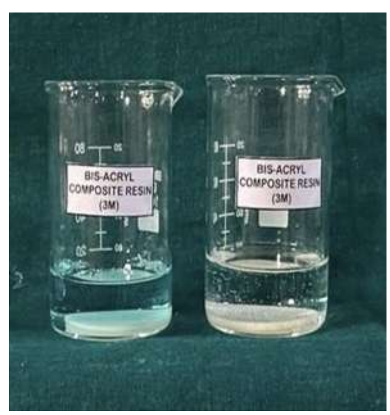
The samples were randomly divided into two groups (n=6 each):

1. Group A: Chlorhexidine mouthwash
2. Group B: Octenidine mouthwash

Immersion Protocol:

Each specimen was immersed in 20 ml of the assigned solution and stored at room temperature. Fresh solutions were maintained to ensure consistency.

Figure 3. Immersion of specimen in Chlorhexidine and Octenidine mouthwash



Color Measurement:

Baseline color values were recorded using a spectrophotometer based on the CIE Lab* color system. Subsequent measurements were taken at 12 hours and 24 hours.

The initial color coordinates (CIE Lab) of the samples were measured using a spectrophotometer. Measurements were made using a white background and under the D65 standard lighting conditions, calibrating the device according to manufacturer's instructions. Average L, a, and b values were recorded by repeating the measurements three times on each sample surface. After a 12 hour and 24 hrs. immersion in solutions, color differences were calculated respectively using the equation based on the L*, a*, b* values

Figure 4. Measurement of colour stability by spectrophotometer

Table 3: Colour measurement after immersion in chlorhexidine

CHLORHEXIDINE									
Provisional Material	Before Immersion			After 12 Hrs.			After 24 Hrs.		
	L*	a*	b*	ΔL*	Δa*	Δb*	ΔL*	Δa*	Δb*
3M	79.344	-1.205	11.379	-0.057	0.003	-0.166	-0.095	0.253	-0.177
	78.963	-1.615	9.967	-0.034	-0.211	-0.124	-0.044	-0.323	-0.122
	78.368	-1.453	11.685	-0.387	-0.03	-0.070	- 0.243	0.196	-0.271
	79.123	-1.264	10.145	-0.249	0.007	-0.122	-0.175	-0.266	-0.103
	78.998	-1.382	10161	-0.300	-0.016	-0.104	-0.495	0.102	0.006
	79.065	-1.518	11.241	-0.086	0.023	-0.274	-0.216	0.100	-0.278

L*: Lightness 0- Darkest

100- Lightest/brightest ΔL*-Changes in lightness

a* : Negative value-Green Positive value-Red Δa*-Changes in green/blue value

b*: Negative value- Blue Positive value- Yellow

Δb*-Changes in blue/yellow value

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TABLE 4: Colour mearsurement after immersion in octenidine mouthrinse

OCTENIDINE									
Provisional Material	**Before Immersion**			**After 12 Hrs.**			**After 24 Hrs.**		
	L*	**a***	**b***	**ΔL***	**Δa***	**Δb***	**ΔL***	**Δa***	**Δb***
3M	78.953	-1.407	10.086	-0.060	-0.135	-0.226	-0.102	-0.271	-0.401
	79.022	-1.821	10.201	-0.024	-0.023	-0.094	-0.024	-0.325	-0.124
	79.344	-1.205	11.379	-0.057	0.003	-0.166	-0.095	0.253	-0.177
	79.123	-1.264	10.145	-0.249	0.007	-0.122	-0.175	-0.266	-0.103
	78.998	-1.382	10161	-0.300	-0.016	-0.104	-0.495	0.102	0.006
	79.065	-1.518	11.241	-0.086	0.023	-0.274	-0.216	0.100	-0.278

The color difference (ΔE) was calculated using the formula:

$\Delta E = \sqrt{[(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]}$

Statistical Analysis:

Data was analyzed using appropriate statistical tests (e.g., independent t-test and ANOVA). p-value < 0.05 was considered as statistically significant.

RESULTS:

NBS unit = ΔE x 0.92

The instrumental analysis revealed that 3M bis-acryl composite material exhibits exceptional color stability when exposed to both chlorhexidine and octenidine. The recorded values were consistently low, indicating that the color changes were clinically imperceptible.

Table 5: Colour change (Δ E) for 3M (Bis-acryl Composite) material after immersion in chlorhexidine and octenidine mouthrinse

Mouth Rinses	**Duration of immersion**	**3M**						
		Specimens						**Mean ±SD**
		1	**2**	**3**	**4**	**5**	**6**	
Chlorhexidine	**After 12 Hours**	0.176	0.247	0.394	0.277	0.317	0.288	0.283 +0.07
	After 24 hours	0.323	0.348	0.413	0.359	0.505	0.366	0.395 +0.06
Octenidine	**After 12 hours**	0.270	0.100	0.152	0.261	0.111	0.212	0.184 +0.07
	After 24 hours	0.495	0.349	0.415	0.365	0.341	0.369	0.389 +0.05

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Both chlorhexidine and octenidine mouthwashes resulted in measurable color changes in the 3M provisional restorative material.

Table 6: One-way ANOVA for material and mouthrinses

Material	Source of Variation	Sum of squares SS	Degree of freedom	Mean square MS	F statistic	P value
3M	**Between Groups**	0.1135	3	0.0378	4.39	0.0165
	Within Groups	0.1720	20	0.0086		
	Total	0.2855	23			

Table 7: Tukey HSD test for 3M bisacryl composite in Chlorhexidine and Octenidine mouthrinses

Material	Solution Pair	Tukey HSD Q Statistic	Tukey HSD p-value	Tukey HSD Indifference
3M	**1 vs 2**	1.51	0.0720	Not Different
	1 vs 3	1.46	0.0865	Not Different
	1 vs 4	1.56	0.0608	Not Different
	2 vs 3	2.97	0.0003	Different
	2 vs 4	0.05	0.9998	Not Different
	3 vs 4	3.02	0.0002	Different

At 12 hours, a mild increase in ΔE values was observed in both groups, with the chlorhexidine group showing slightly higher discoloration. At 24 hours, the difference became more pronounced, with chlorhexidine demonstrating greater staining compared to octenidine.

The results indicate a time-dependent increase in discoloration for both solutions, with chlorhexidine consistently exhibiting higher staining potential.

Figure 5. Colour change after immersion in Chlorhexidine and Octenidine for 24 hours

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Discussion

Regardless of their chemistry, dental polymers do undergo a certain amount of adsorption of the liquids from the surrounding environment and hence tend to change colour over time.8 The discoloration may arise for a number of reasons, including an internal color change of the resinous material itself.14 The degree of color change can be affected by a number of factors, including incomplete polymerzation, water sorption, chemical reactivity, Diet, oral hygiene, and surface smoothness of the restoration.15 The findings of this study highlight the susceptibility of bis-acryl provisional materials to staining when exposed to antiseptic mouthwashes. Chlorhexidine demonstrated a significantly higher staining effect compared to octenidine, which aligns with previous studies attributing chlorhexidine-induced staining to its interaction with dietary chromogens and precipitation of pigmented compounds.

Provisional restoratives are prone to absorbing liquids from which staining may readily generate colour changes, even while the use of stabilizers has reduced the incidence of chemically induced colour material alterations.10

The relatively lower staining observed with octenidine may be due to its different chemical structure and mechanism of action, which may result in reduced interaction with the resin matrix of the provisional material. The necessary physical attributes of temporary restorative materials include minimal temperature variations during polymerization, high surface hardness, good marginal fit, wear resistance, transverse strength, transverse repair strength, high polishability, colour stability, and stain resistance.

To put our results into perspective, it is important that we know the visual perception thresholds for colour changes. According to Seghi and Grit11 it is 50% perceivable to observers when the ΔE is 1.0 under standard illumination, while above 2.0 is perceivable to almost everyone.11

The clinical implication of these findings is particularly important in aesthetic zones, where discoloration of provisional restorations can negatively impact patient satisfaction. Dentists should consider prescribing mouthwashes with lower staining potential, such as octenidine, especially for patients undergoing long-term provisionalization. Provisional resin restorations may be worn over a long period, to asses th e results of periodontal and endodontic therapies, and during the restorative phase of implant reconstructive procedures.9

Limitations of this study include its in vitro design, which may not fully replicate intraoral conditions such as saliva, temperature fluctuations, and dietary influences. Future in vivo studies are recommended to validate these findings.

The human perception of color is complex and encompasses both subjective and objective phenomena.13 Many laboratory investigations have focused on the internal discoloration of restorative resins, and it is known that several factors are involved in the color forming process.14 Within the limitations of this study, chlorhexidine mouthwash demonstrated significantly higher staining potential on 3M bis-acryl provisional restorative material compared to octenidine. Octenidine may be considered a preferable alternative in clinical situations where aesthetic stability is important.

However, the degree of color change can be affected by a number of factors, including incomplete polymerization, water sorption, chemical reactivity, diet, oral hygiene, and surface smoothness of the restoration15-18

Conclusion

Within the limitations of this study, chlorhexidine mouthwash demonstrated significantly higher staining potential on 3M bis-acryl provisional restorative material compared to octenidine. Octenidine may be considered a preferable alternative in clinical situations where aesthetic stability is important.

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