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Comparative Assessment Of Colour Stability Of DPI Provisional Restorative Material Following Exposure To Chlorhexidine And Octenidine Mouthrinses: An In Vitro Study

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Abstract

Introduction:
Provisional restorative materials protect prepared teeth and maintain esthetics during treatment. However, exposure to mouthwashes like chlorhexidine and octenidine can cause discoloration, affecting their appearance.

Objective:
To compare the color stability of DPI provisional restorative material after exposure to chlorhexidine and octenidine mouthrinses.

Materials and Methods:
An in vitro comparative study was designed using standardized disc-shaped specimens fabricated from DPI self-cure provisional restorative material (Shade A2). Twelve specimens were prepared and randomly allocated into two groups (n = 6): chlorhexidine and octenidine. Baseline colour measurements were obtained using a spectrophotometer based on the Commission Internationale de l'Éclairage (CIE) Lab* colour system. Following immersion according to the experimental protocol, colour differences (ΔE) were calculated using the standard CIE equation. Descriptive and inferential statistical analyses were planned to compare colour changes between the study groups.

Results:
Both mouthrinses caused significant color changes ($p < 0.05$), with chlorhexidine producing greater discoloration than octenidine.

Conclusion:
Chlorhexidine has a higher staining effect on DPI provisional restorative material. Octenidine may be a better option for preserving color stability in provisional restorations.

Keywords: Chlorhexidine, Colour Stability, DPI Provisional Restorative Material, Octenidine, Provisional Restorations, Spectrophotometry

Introduction

Fixed prosthodontics depends on interim restorations to ensure continuity of function, protection of prepared tooth structures, and maintenance of esthetics during the interval before placement of the definitive prosthesis[1]. These provisional restorations are not merely temporary substitutes but play a crucial role in preserving occlusal relationships, supporting surrounding tissues, and allowing clinical evaluation of treatment outcomes. DPI provisional restorative material is frequently employed in clinical practice owing to its convenient handling characteristics, economic advantage, and acceptable short-term performance[2].

With increasing emphasis on esthetic dentistry, the visual stability of provisional restorations has become an important consideration. Colour stability is particularly significant, as any perceptible change in shade during the provisional phase can negatively influence patient perception and satisfaction[3]. Resin-based materials such as DPI are inherently prone to discoloration due to physicochemical properties, including water uptake and surface interactions with external agents[4] .

Chlorhexidine and octenidine mouthrinses are commonly recommended for their antimicrobial efficacy in maintaining oral hygiene. However, their prolonged use has been associated with staining effects on both natural teeth and restorative materials[5][6]. The interaction between these agents and provisional restorative materials may lead to noticeable colour alterations, especially when restorations are present in esthetically critical areas.

Octenidine dihydrochloride is a newer bispyridine antiseptic that has gained popularity because of its excellent antimicrobial efficacy against Gram-positive bacteria, Gram-negative bacteria, fungi, and certain viruses. Compared with chlorhexidine, octenidine demonstrates lower cytotoxicity, minimal bacterial resistance, prolonged substantivity, and reportedly reduced staining potential. Consequently, octenidine has emerged as a promising alternative for long-term chemical plaque control in dental patients.[35,36,37]

Considering the frequent clinical use of DPI provisional restorative material alongside these mouthrinses, it is essential to investigate their influence on colour stability.

Objective:

This in vitro study aims to evaluate and compare the colour stability of DPI provisional restorative material following exposure to chlorhexidine and octenidine mouthrinses using spectrophotometric analysis.

1. To evaluate the colour stability of DPI provisional restorative material after immersion in chlorhexidine mouthrinse.
2. To evaluate the colour stability of DPI provisional restorative material after immersion in octenidine mouthrinse.
3. To compare the colour changes produced by the two mouthrinses using the CIE L*a*b* colour system.
4. To determine the clinical significance of colour change using the National Bureau of Standards (NBS) classification.
5. To assess the potential implications of mouthrinse selection on the aesthetic longevity of provisional restorations

Materials And Methods

Study Design

The present in vitro comparative experimental study was conducted in the Department of Oral and Maxillofacial Prosthodontics and Implantology, Karnavati School of Dentistry, Karnavati University, Gujarat, India, to evaluate the effect of chlorhexidine and octenidine mouthrinses on the colour stability of DPI provisional restorative material using spectrophotometric analysis.[7]

Study Duration

The study was conducted over a period of three months, including specimen fabrication, finishing and polishing, immersion procedures, colour evaluation, and statistical analysis

Material Used

DPI tooth moulding material (polymethyl methacrylate; chemically polymerized; shade A2; DPI) was selected for the study. The test solutions included chlorhexidine and octenidine mouthrinses, along with distilled water used for storage[8].

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Commercial name	Composition	Dispensing system	Polymerization	Shade	Manufacturer
DPI tooth moulding material	Poly methyl methacrylate	Polymer & monomer	Chemically cure	A2	DPI

Armamentarium And Equipment

1. Metal ring mould
2. Lecron carver
3. Wax spatula
4. Dappen dish
5. Glass plate with petroleum jelly
6. Dispensing gun
7. Tungsten carbide bur (DFS- Germany)
8. Sand paper nos. 100µ, 120µ
9. Pumice
10. Polishing cake
11. Cotton buff
12. Spectrophotometer (Premier Colorscan)
13. Thermocycling incubator
14. CAD/CAM software (EXOCAD)
15. Milling unit

Sample Preparation

A total of 12 disc-shaped specimens were fabricated using DPI provisional restorative material. All samples were standardized to 3.5 cm in diameter and 1.5 mm in thickness, with shade A2 maintained for uniformity[9] .The material was prepared by mixing polymer and monomer according to the manufacturer's instructions and loaded into a lubricated mould placed on a glass plate. A second glass plate was placed over the mould to obtain a uniform surface, and specimens were retrieved after complete polymerization[10].

The specimens were randomly divided into two experimental groups.

Group I: Chlorhexidine mouthrinse (n = 6)

Group II: Octenidine mouthrinse (n = 6)

Finishing And Polishing

The specimens were trimmed using tungsten carbide burs and subsequently finished using abrasive papers of 100 µm and 120 µm grit. Final polishing was performed using pumice followed by polishing cake with a cotton buff to achieve a smooth surface finish[11] .

Grouping And Storage

All specimens were stored in distilled water at room temperature for 24 hours. The samples (n=12) were then randomly divided into two groups (n=6 each):

- Group I: Immersion in chlorhexidine
- Group II: Immersion in octenidine

Colour Measurement

Baseline colour values were recorded using a spectrometer based on the CIE Lab system under standardized D65 illumination. Three readings were obtained for each specimens and mean values were calculated [12]. Following immersion for 12 and 24 hours , colour changes(ΔE) were calculated using the formula;

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

To simulate intraoral conditions, specimens were maintained at 37°C using a thermocycling unit. After immersion, samples were rinsed with distilled water, dried, and re-evaluated[13].

Where

L* = Lightness (0 = black, 100 = white)

a* = Green (−) to Red (+)

b* = Blue (−) to Yellow (+)

Colour Difference Interpretation

The obtained ΔE values were converted into National Bureau of Standards (NBS) units (ΔE × 0.92) to determine the clinical significance of colour change[14] .

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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

Image Files:

Figure 1: DPI (Self Cure) Tooth Moulding Material

Figure 2: Manupulation Of Sample From DPI Material

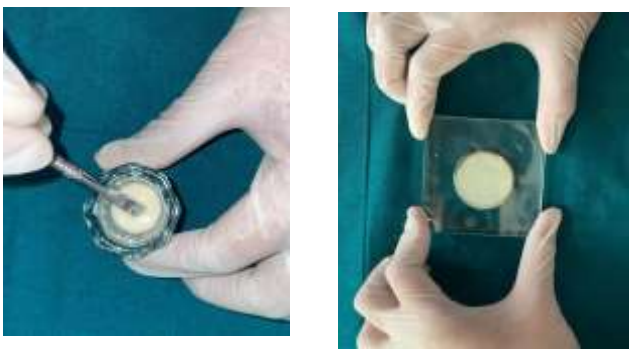

Figure 3 : Specimens Prepared From DPI Provisional Material

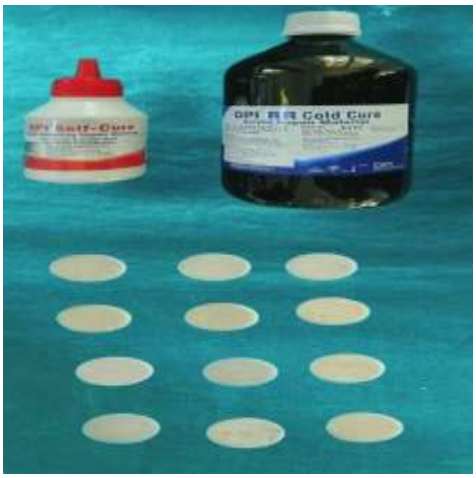

Figure 4 : Chlorhexidine And Octenidine Mouthrinses

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Figure 5 : Immersion Of Specimens In Chlorhexidine And Octenidine Mouthrinses

Figure 6 :Measurement Of Colour Stability With Spectrophotometer

Figure 7 : Specimens After Immersion In Chlorhexidine And Octenidine Mouthrinses For 24 Hours

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Observations and Results:

TABLE 1: 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***
DPI	75.968	0.297	10.897	-0.009	0.082	-0.038	0.120	-0.031	0.318
	76.196	0.827	11.836	-0.125	-0.218	-0.504	-0.021	-0.507	-0.247
	75.984	0.487	10.954	-0.010	-0.030	-0.090	-0.060	-0.191	-0.463
	76.068	0.642	11.258	-0.060	-0.026	-0.227	-0.390	0.186	-0.146
	74.980	0.727	10.968	-0.208	0.042	-0.564	-0.288	0.043	0.564
	76.365	0.745	9.845	-0.183	-0.042	-0.166	-0.380	-0.046	-0.190

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

TABLE 2: 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***
DPI	76.270	0.885	12.097	-0.007	-0.088	-0.068	0.017	-0.295	-0.055
	76.233	0.821	11.944	0.011	-0.003	0.038	-0.062	-0.362	-0.335
	76.296	0.827	11.836	-0.125	-0.218	-0.504	-0.021	-0.507	-0.247
	76.041	0.642	11.258	-0.060	-0.026	-0.227	-0.390	0.186	-0.146
	76.103	0.745	9.845	-0.183	-0.042	-0.166	-0.380	-0.046	-0.190
	75.984	0.487	10.954	-0.010	-0.030	-0.090	-0.060	-0.191	-0.463

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TABLE 3: Colour Change (Δ E) For DPI (Self-Cure) Material After Immersion In Chlorhexidine And Octenidine Mouthrinse

Mouth Rinses	Duration of immersion	DPI						
		Specimens						Mean ±SD
		1	2	3	4	5	6	
Chlorhexidine	After 12 hours	0.091	0.563	0.095	0.236	0.602	0.250	0.306 +0.22
	After 24 hours	0.341	0.564	0.404	0.456	0.635	0.409	0.466 +0.11
Octenidine	After 12 hours	0.040	0.111	0.082	0.154	0.062	0.257	0.11+ 0.07
	After 24 hours	0.301	0.497	0.123	0.296	0.215	0.418	0.308 +0.13

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

= Change in Colour/Shade

TABLE 4: Mean Value Of Colour Change (Δ E) And National Bureau Of Standards (NBS) Unit Of Each Material After Immersion In Mouth Rinses

Mouth rinses	Duration of immersion	DPI	
		Δ E (Mean± SD)	NBS Unit
Chlorhexidine	After 12 hrs.	0.306+0 .224	0.281
	After 24 hours	0.466+0 .110	0.428
Octenidine	After 12 hrs.	0.11+0. 078	0.101
	After 24 hours	0.308+0. 134	0.283

NBS unit = ΔE x 0.92

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TABLE 5: Colour Difference After Immersion In Chlorhexidine And Octenidine

Duration	Mouth rinses	Colour Difference
		DPI
After 12 hrs.	Chlorhexidine	trace
	Octenidine	trace
After 24 hours	Chlorhexidine	trace
	Octenidine	trace

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
DPI	Between groups	0.2906	3	0.0969	6.57	0.0037
	Within Groups	0.2950	20	0.0147		
	Total	0.5856	23	0.0969		

TABLE 7: Tukey HSD Test For DPI In Chlorhexidine And Octenidine Mouthrinses

Material	Solution Pair	Q Statistic	P value	Indifference
DPI	CHX 12hr vs CHX 24 hr	1.10	0.2589	ND
	CHX 12hr vs OCT 12 hr	1.28	0.1539	ND
	CHX 12hr vs OCT 24 hr	0.01	1.0000	ND
	CHX 24hr vs OCT 12 hr	2.38	0.0028	D
	CHX 24hr vs OCT 24 hr	1.08	0.2694	ND
	OCT 12hr vs OCT 24 hr	1.29	0.1471	ND

CHX = Chlorhexidine OCT = Octenidine hr= Hours ND= Not Difference D= Difference

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Discussion:

Self-cure acrylic resins such as DPI tooth moulding material continue to be widely used for provisional restorations because of their affordability, ease of manipulation, and satisfactory short-term performance. However, maintaining colour stability remains a challenge, particularly when these materials are exposed to antimicrobial mouth rinses routinely prescribed during treatment.

In the present study, the colour stability of DPI material was assessed following immersion in chlorhexidine and octenidine solutions for 12 and 24 hours. The findings revealed that DPI exhibited the greatest degree of colour change among all tested conditions. The highest mean colour change (ΔE) was observed after 24 hours of immersion in chlorhexidine, recorded as **0.466 ± 0.110**, whereas comparatively lower values were noted with octenidine at both time intervals. Although these values fall below the commonly accepted clinical threshold of $\Delta E \geq 3.3$, they approach the level where colour differences may begin to be perceptible under controlled conditions.[15,16,17]

The tendency of DPI to undergo greater discoloration can be attributed to its inherent material characteristics. As a self-cure polymethyl methacrylate (PMMA)-based resin, it exhibits a lower degree of cross-linking along with the presence of residual unreacted monomers. This leads to increased porosity and formation of microvoids within the material, which act as pathways for the ingress of staining agents.[18,19,20] Furthermore, its relatively higher water sorption capacity facilitates both absorption and adsorption of pigments from surrounding media, thereby accelerating colour alteration.[21]

When comparing the two mouth rinses, chlorhexidine demonstrated a more pronounced staining effect on DPI material than octenidine. This observation aligns with previous reports that attribute chlorhexidine-induced discoloration to its interaction with chromogenic substances, resulting in deposition of pigmented compounds on material surfaces[22] . Additionally, chlorhexidine is known to undergo chemical reactions that lead to formation of brownish stains over time.[23] In contrast, octenidine is generally associated with a lower staining tendency; however, the present findings indicate that prolonged exposure still results in measurable colour change, suggesting a time-dependent cumulative effect.

Discoloration in DPI material occurs through both intrinsic and extrinsic mechanisms. Intrinsically, water diffusion into the polymer matrix can initiate hydrolytic degradation and oxidation of residual monomers, leading to internal colour changes.[24] Extrinsically, pigments from the surrounding solution can adhere to and penetrate the surface, particularly when surface irregularities are present. The relatively less dense and loosely cross-linked polymer structure of DPI further facilitates this process.[25]

Another important factor influencing colour stability is the polymerization chemistry of self-cure acrylic resins. These materials rely on tertiary amine accelerators, which are susceptible to oxidation, resulting in gradual yellowing of the material.[26] Moreover, manual mixing during fabrication may introduce air bubbles and inconsistencies, increasing surface roughness and promoting stain retention.[27]

The progressive increase in ΔE values with longer immersion times observed in this study highlights the cumulative nature of discoloration. Even though the experimental design simulated short-term exposure, the trend suggests that repeated clinical use of chlorhexidine mouthwash could significantly affect the aesthetic appearance of DPI provisional restorations over time.

Overall, the findings of this study indicate that DPI self-cure acrylic resin is more prone to discoloration, particularly when exposed to chlorhexidine, as compared to octenidine. This behaviour is largely governed by its physicochemical properties, including porosity, residual monomer content, and water sorption characteristics. From a clinical standpoint, careful consideration should be given when prescribing chlorhexidine to patients with long-term provisional restorations made from DPI, especially in aesthetically sensitive regions.

Limitations:

1. The study was performed under in vitro conditions, which cannot fully reproduce the oral environment, where saliva, pH fluctuations, temperature changes, and masticatory forces may influence the colour stability of DPI acrylic resin[28,29]

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2. Distilled water was used as a control medium; however, natural saliva contains proteins, enzymes, and electrolytes that can interact with acrylic resins and alter staining behaviour.[28]
3. The continuous immersion periods (12 and 24 hours) do not reflect actual clinical use, where mouth rinses are used intermittently for short durations (30–60 seconds), possibly leading to an overestimation of discoloration.[30]
4. Only one brand of DPI self-cure acrylic resin was evaluated; variations in formulation, residual monomer content, and degree of polymerization among different products may produce different outcomes.[31]
5. The study was limited to two mouth rinses (chlorhexidine and octenidine), whereas other formu lations such as alcohol-based, fluoride-containing, or herbal rinses may exhibit different staining potentials.[32]
6. The use of standardized flat disc-shaped specimens does not replicate the anatomical contours of clinical restorations, where irregular surfaces may increase plaque retention and staining.[33]

Clinical finishing and polishing procedures were not simulated; surface roughness in actual restorations can significantly influence stain accumulation, especially in porous materials like DPI acrylic resin.[34]

Summary :

From a practical clinical standpoint, the results suggest that the use of DPI self-cure acrylic resin should be carefully considered when patients are advised to use antimicrobial mouth rinses. DPI material has shown a tendency to undergo colour changes, particularly with chlorhexidine, which is commonly prescribed in routine dental practice.

In cases where provisional restorations are required only for a short duration and aesthetics are not a major concern, DPI can still be used effectively. However, in situations where the restoration is visible or needs to be maintained for a longer period, the possibility of discoloration should be kept in mind.

Therefore, while DPI remains a convenient and cost-effective option, clinicians should be cautious about its use in aesthetically important areas, especially when long-term exposure to staining mouth rinses is expected.

Strengths of the Study :

1. Evaluation of a commonly used Indian provisional restorative material (DPI self-cure PMMA).
2. Objective colour assessment using spectrophotometry.
3. Standardized specimen fabrication and polishing protocol.
4. Direct comparison of two commonly prescribed antimicrobial mouthrinses.
5. Colour evaluation based on the internationally accepted CIE L*a*b* colour system.

Future Recommendations

Future investigations should:

1. Compare multiple provisional restorative materials.
2. Include artificial saliva and thermocycling.
3. Simulate routine mouthrinse use with intermittent immersion.
4. Evaluate long-term colour stability.
5. Correlate colour stability with surface roughness and water sorption.
6. Conduct randomized clinical trials to validate laboratory findings.

Conclusion:

1. DPI (self-cure acrylic resin) showed a clear tendency to undergo colour change when exposed to both mouth rinses.
2. The extent of discoloration was greater with chlorhexidine compared to octenidine.
3. The difference in colour change between the two solutions was noticeable and statistically significant.
4. The increase in colour change with longer exposure suggests that staining is time-dependent in DPI material.
5. From a clinical point of view, DPI may be more prone to aesthetic compromise, especially when patients are advised to use chlorhexidine for extended periods.

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Ethical Statement :

The present investigation was an in vitro laboratory study performed exclusively on dental materials. No human participants or experimental animals were involved. Therefore, institutional ethical approval and informed consent were not applicable.

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