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Comparative evaluation of three polishing systems on color stability of omnichroma using spectrophotometer: an in-vitro study

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Abstract

Introduction: A smooth surface is important to prevent discoloration and plaque accumulation, which degrades aesthetics and increase caries risk and gingival inflammation. Several studies have assessed different finishing and polishing systems using various types of composite resins. Considering that simplified systems are less time consuming, it is important for dental practitioners to know what systems offer adequate surface quality to improve both aesthetics and longevity of composite restorations. Different polishing techniques enhance the color stability of the resin composite thus contributing to the aesthetics. Hence, choosing an aesthetic composite material with adequate polishing system is vital to avoid frequent replacements and subsequent effects on remaining tooth structure.

Aim: To assess the different polishing systems on the color stability of supra-nanocomposite resins.

Methodology: A total of 180 extracted teeth restored with omnichroma were selected for this study. Based on the polishing system used, sixty samples were divided into three groups. Group I: Pravis TDV + Diamond Paste, group II:Sof-Lex System Discs, and group III: Super Snap Rainbow Technique kit. The samples in each group were immersed in beverage, that is Distilled water, tea and Cola. Spectrophotometer was used to measure the color of the samples after staining period.

Results: Results showed that highest mean delta E21 was observed with Praxis TDV + Diamond Paste (5.43±4.14) followed by Super Snap Rainbow Technique Kit (4.67±3.55) and lowest mean delta E21 was observed in Sof-Lex (4.52±3.50). However, statistical analysis using ANOVA showed that there were no statistically significant differences in mean ΔE21 among the three materials (P=0.858).

Clinical significance: Excellent finishing and polishing are the critical steps to enhance the esthetics and longevity of the composite restorations. High strength, fracture toughness, surface hardness, optimum polishability, and gloss are the functional properties which need assessment while a resin composite is used for restoration.

Keywords: Color stability, Omnichroma, Supra-nano Composite.

Introduction

One of the most admired features of restorative materials is their aesthetics.[1] Ever since the introduction, Resin – based composites have been continuously evolving to the growing demands of aesthetic dental applications.[2] Composite resin is extensively used as a dental restorative material, although it remains a challenge to identify appropriate polishing systems to obtain high surface gloss and color stability. A smooth surface is important to prevent discoloration and plaque accumulation, which degrades aesthetics and increase caries risk and gingival inflammation.[3] The surface quality of composite resin is influenced by several factors, including filler particle size, filler loading, resin content, type of filler and particle morphology.[4]

Traditionally, ideal polishing protocols have been explained as a selective wear process using a sequence of abrasive particles from coarse grit gradually decreasing toward fine grit.[5]Currently, a variety of polishing systems are commercially available.

Resin composites have been widely used because of their aesthetics, good mechanical properties, and ease of handling. Omnichroma was introduced with such properties which acted on principle of structural color having a filler size particle of 260nm. The color of a resin composite is correlated with the light scattering and absorption characteristics, reflectivity, and translucency of the material.[5] Resin dental restorative materials are exposed to a variety of solutions such as tea, coffee, nicotine, cola drinks or other beverages and mouth rinses which may cause staining.[6]

Different polishing techniques enhance the color stability of the resin composite thus contributing to the aesthetics. Hence, choosing an aesthetic composite material with adequate polishing system is vital to avoid frequent replacements and subsequent effects on remaining tooth structure.[7]Thus, the objective of this study is to evaluate the three different polishing systems on class V cavities restored with omnichroma and color stability post polishing after immersion in different beverages.

Materials and Method

The present in vitro study was conducted in the Department of Conservative Dentistry and Endodontics, Himachal Pradesh Government Dental College and Hospital, Shimla, H.P.

Preparation of Samples

A total of 180 samples of extracted teeth on which class V cavities, restored with omnichroma were included. After the above steps, the samples were then cured in increments for 40 seconds. Later, the cured samples were stored in distilled water at 37°C for 24 hours, before the finishing procedures. Baseline color of the

samples was measured using spectrophotometer. (Fig. 1-16)

Polishing Groups

Based on the polishing system used, 180 samples were divided into three groups.

Group I: Praxis TDV + Diamond Paste(TDV Dental)

Group II: Sof-Lex (3M ESPE, St Paul, MN, USA)

Group III: Shofu super-snap polishing disks (Shofu Inc., Kyoto, Japan) used from coarse to super fine, each for 15 seconds, total of 60 seconds.

Staining

The beverage used to dip the samples in each group was Distilled water, Tea and Cola. Specimens were immersed for a duration of 15mins/day for 21 days. After the immersion time, the samples were kept in distilled water for the remainder of the day at room temperature. The color stability of polished specimens before immersion, 7 days, and 21 days after immersion was measured using a Spectrophotometer by selecting three samples from each group randomly.

Color Stability

The spectra of the sample and difference in color was expressed based on CIE L*, a*, b* color space system established by International Commission on Illumination.

L*, a*, b* depicts:

L* coordinate – Perpetual Lightness

a* b* - Chromaticity of color with axes varying from green to red and blue to yellow respectively.

The total color difference was calculated by:-

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

Figure 1: Sample Collected for the Study

Figure 2: Praxis TDV+Diamond Paste

Figure 3:Sof-Lex System DiscsFig

Figure 4: Super- Snap Rainbow Technique Kit

Figure 5: Armamentarium Used

Figure 6: Class V Preparation

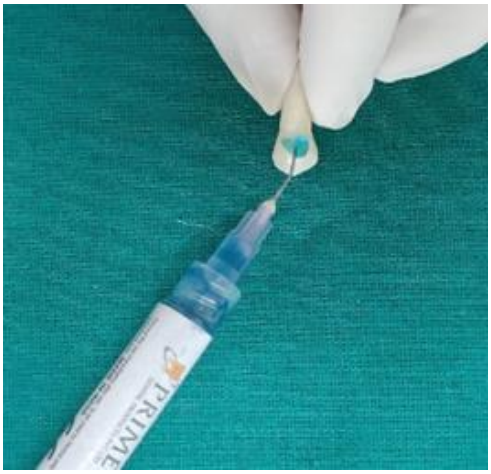

Figure 7: Application of Etchant

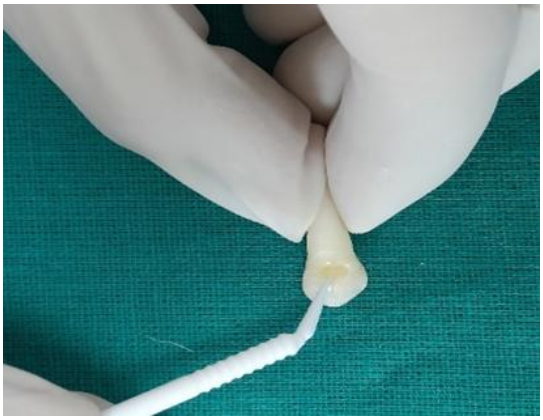

Figure8: Application of Bonding Agent

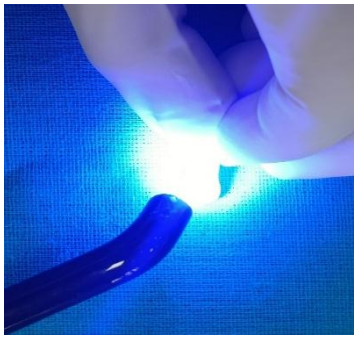

Figure 9: Light Curing for 20s

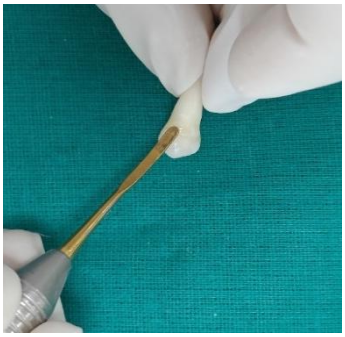

Figure 10: Omnichroma Placement

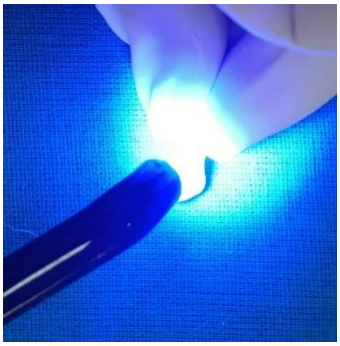

Figure 11: Light Curing for 40s

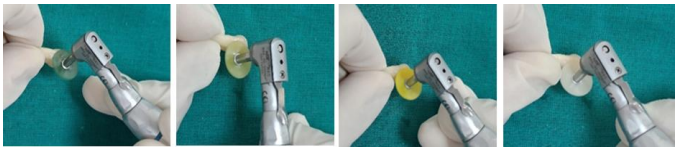

Figure 12: Polishing the samples with Praxis TDV + Diamond Polishing Paste

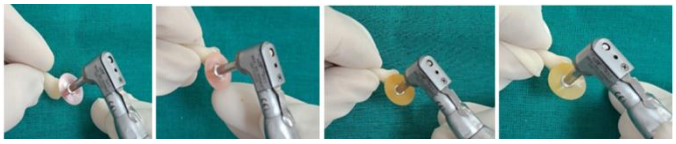

Figure 13: Polishing the samples with Sof-Lex System Discs

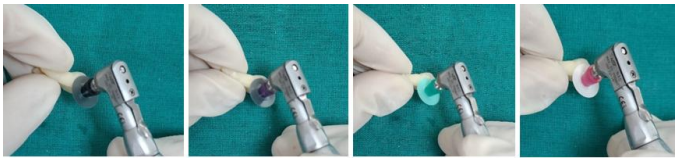

Figure 14: Polishing the samples with Super-Snap Rainbow Technique Kit

Figure 15: Immersion of the polished samples

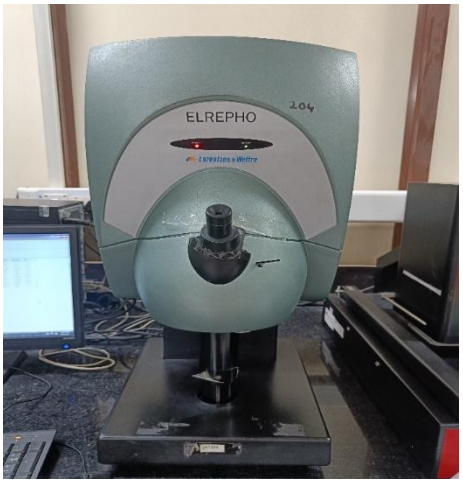

Figure 16: Spectrophotometer used for this studyin designated beverages

Statistical Analysis

The statistical analysis was done using Statistical Package for the Social Sciences (SPSS for Windows, Version 19.0). Descriptive statistics for ΔE_{21} were calculated as mean and standard deviation. The comparison of mean ΔE_{21} among various materials and beverages was done using Analysis of Variance (ANOVA). In case the ANOVA presented statistically significant outcomes, pair wise comparisons were done using Tukey's post-hoc test. The level of significance for the present study was fixed at a p-value of less than 0.05.

Results

Distilled Water

Table 1: Shows the comparison of Delta E21 among various materials immersed in distilled water. Statistical analysis using ANOVA showed that there were no statistically significant differences in mean ΔE_{21} among the three materials when immersed in distilled water (P=0.897).

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Praxis TDV + Diamond Paste	3	.0233	.01155	.00667	-.0054	.0520	.01	.03
Sof-Lex	3	.0267	.00577	.00333	.0123	.0410	.02	.03
Super Snap Rainbow	3	.0233	.01155	.00667	-.0054	.0520	.01	.03
Total	9	.0244	.00882	.00294	.0177	.0312	.01	.03

Tea

Table 2 shows the comparison of Delta E21 among various materials immersed in tea. Statistical analysis using ANOVA showed that there were no statistically significant differences in mean ΔE_{21} among the three materials when immersed in tea (P=0.395).

Table 2:

Comparison of Delta E21 among various materials immersed in tea

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Praxis TDV + Diamond Paste	3	7.5300	.97180	.56107	5.1159	9.9441	6.41	8.15
Sof-Lex	3	6.2100	1.53385	.88557	2.3997	10.0203	4.44	7.15
Super Snap Rainbow	3	6.9333	.56368	.32544	5.5331	8.3336	6.30	7.38
Total	9	6.8911	1.10969	.36990	6.0381	7.7441	4.44	8.15

Coca-Cola

Table 3 shows the comparison of Delta E21 among various materials immersed in coca-cola. Statistical analysis using ANOVA showed that there were no statistically significant differences in mean ΔE_{21} among the three materials when immersed in coca-cola (P=0.121).

Table 3:

Comparison of Delta E21 among various materials immersed in coca-cola

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Praxis TDV + Diamond Paste	3	8.7633	.82585	.47681	6.7118	10.8149	7.81	9.26
Sof-Lex	3	7.3400	.48775	.28160	6.1284	8.5516	6.79	7.72
Super Snap Rainbow	3	7.0767	1.22349	.70638	4.0373	10.1160	5.71	8.07
Total	9	7.7267	1.10532	.36844	6.8770	8.5763	5.71	9.26

Table 4 shows the overall comparison of Delta E21 among various materials across all the three beverages used in the study. Results showed that highest mean delta E21 was observed with Praxis TDV + Diamond Paste (5.43±4.14) followed by Super Snap Rainbow Technique Kit (4.67±3.55) and lowest mean delta E21 was observed in Sof-Lex (4.52±3.50). However, statistical analysis using ANOVA showed that there were no statistically significant differences in mean ΔE_{21} among the three materials (P=0.858).

Table 4:

Overall comparison of Delta E21 among various materials

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Praxis TDV + Diamond Paste	9	5.4389	4.14596	1.38199	2.2520	8.6258	.01	9.26
Sof-Lex	9	4.5256	3.50315	1.16772	1.8328	7.2183	.02	7.72
Super Snap Rainbow Technique Kit	9	4.6778	3.55577	1.18526	1.9446	7.4110	.01	8.07
Total	27	4.8807	3.62229	.69711	3.4478	6.3137	.01	9.26

Discussion

Esthetics being the current need of the era, often motivates patients to seek dental treatment. Composite resin restorations constitute a significant portion of dentist's routine practice due to the patient's increasing demand for an aesthetic appearance. Surface treatments to achieve a smooth and polished surface have been described as an effective way to enhance the color stability of resin composite restorations.[8-9]

Since India has long summers in most places, coca cola is consumed in large amounts in Indian soft drink industry. So these popular beverages consumed in India, tea and coca cola were selected for stainability testing with omnichroma composite in this study.

With the evolution of composite resins and finishing and polishing materials, more studies are necessary to determine the best indications of their use to achieve restoration longevity.

GhadaAlharbi (2024)[10] evaluated the effect of different finishing and polishing systems on surface properties of universal single shade resin-based composites. This study evaluated the effect of different finishing and polishing (F/P) systems on surface roughness (Ra), surface gloss (GU), and Vickers microhardness (VMH) of universal single-shade RBCs.Omnichroma showed the lowest Ra and acceptable GU, but the lowest VMH.

Marta Ewa Szczepaniak (2022)[11] evaluated the Effect of Various Polishing Systems on the Surface Roughness of Two Resin Composites, and polished by Sof-Lex, Sof-Lex Diamond Polishing System, Super Snap, One Gloss, Astrobrush, Stainbuster, Enamel Shiny, and Jiffy Polishing System. In this study, the best smoothness of both tested materials were obtained by the Sof-Lex and Super Snap systems.

Khairy et al. (2022)[12] evaluated the effect of Finishing/Polishing Techniques on Surface Roughness of Three Different Resin Composite Materials. Nano-fill resin composite (Omnichroma); a Nanoceramic resin composite (Neo Spectra ST) and a Nano-hybrid resin composite (Charisma Topaz) was selected for this study. Each group was subdivided into four subgroups (n=10) according to the finishing/polishing (F/P) system: control (without F/P), one-step system (Enhance); two-step system (Super Snap Rainbow); and three-step system (Soflex). The results obtained from this study showed that the lowest surface roughness values were recorded with the Nano-fill resin composite.

The spherical shaped particles of the Nano-fill resin composite showed lower surface roughness than the hybrid shaped particles. This might be due to that the irregular shaped filler particles can be subjected to more friction during the polishing process as they have sharp edges and corners that can be easily removed.[13]

Smooth surface enables clinical durability, good aesthetic appearance, better optical compatibility with natural enamel tissue and surface gloss, as well as, preventing the discoloration and staining of the restoration.

There are many dental processing methods for obtaining good surface quality. The final processing of restoratives includes contouring, finishing and polishing procedures in order to obtain the adequate anatomical morphology of the restoration and the satisfying surface quality.[14] Some dental polishing procedures recommend the so called “high gloss polishing” or “paste-polishing” with application of polishing aluminium-dioxide or diamond pastes for the intraoral use at the end of the restorative treatment.[15]

The results of current study are supported by Kiran Murthy Dhananjaya et al (2011)[16]which conclude that when the composites were polished with Sof-Lex, they provided a superior polish compared to Astropol polishing group and Shofu super-snap polishing group and there was only a minimal difference in the color stability of the composite between the groups when subjected to tea.

In the present study, tooth preparation resorted with omnichroma composite stained considerably in Coco-cola beverage compared to tea and distilled water as depicted by lower ΔE values over 21 day challenge.

In the present study, coco-cola beverage exhibited lowest pH and such a pH may affect the surface integrity of materials leading to softening of the matrix, loss of structural ions such as calcium, aluminium, and silicone from the glass filler phase.[17] In addition, the composite resin restorative materials may exhibit higher water sorption in acidic media thus facilitating staining of the composite resins. Tea exhibits higher pH than coca cola and hence the staining is less compared to coca cola.

Limitations

In the present study, parameters were measured up to 21 days, however more long-term clinical studies or in vitro studies with better simulation of the oral environment are necessary to validate the findings.

Moreover, only one supra-nanocomposite was used. To come to an appropriate conclusion on the color stability, newer composites must be included.

Therefore, in future further in vivo studies with large samples are required to support the results of this study.

Conclusion

Within the scope of this in vitro study, we conclude that when the composites were polished with Sof-Lex, they provided a superior polish compared to Praxis TDV + Diamond Paste polishing group and Shofu super-snap polishing group. There was only a minimal difference in the color stability of the composite between the groups.

Conflict Of Interest: None

Acknowledgement : The institution (H.P. Government Dental College and Hospital) , Shimla, India.

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