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Comparative Clinical Evaluation of Smart Monochromatic Composite and Traditional Multi-Shade Composite in Primary Teeth Restorations: A Randomized Clinical Study

Sridhar M[1], Himasree Kanneganti[2], Naseemoon Shaik[3], Sravanthi. J[4], Snehika G[5], Pravallika Bheema[6], Divya Madhuri[7]

[1]Professor & Head of the Department, Department of Pedodontics & Preventive Dentistry, MNR Dental College, Sangareddy, Telangana.
[2,6,7]Postgradute student, Department of Pedodontics & Preventive Dentistry, MNR Dental College, Sangareddy, Telangana.
[3,4]Associate Professor, Department of Pedodontics & Preventive Dentistry, MNR Dental College, Sangareddy, Telangana.
[5]Senior Lecturer, Department of Pedodontics & Preventive Dentistry, MNR Dental College, Sangareddy, Telangana.

Corresponding Author: Dr. Naseemoon Shaik

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ABSTRACT

Background: Dental esthetics in children significantly influences oral function, psychological well-being, and social acceptance. Pediatric restorative procedures often face challenges related to behavior management and treatment duration. While traditional multi-shade composites offer excellent esthetics, they require precise shade matching, increasing chairside time. Smart monochromatic composites have been introduced to overcome these limitations through color-adaptive filler technology.

Aim and Objectives: This study aimed to compare smart monochromatic composites and traditional composites in terms of treatment duration, patient acceptance, and short-term color stability in primary anterior tooth restorations.

Methods: A randomized clinical trial was conducted among 40 systemically healthy children (4–9 years). Teeth were randomly assigned to:Group 1: Traditional multi-shade composite (n=20). Group 2: Smart monochromatic composite (n=20). Standard etch-and-bond protocols were followed. Treatment duration was recorded, patient acceptance was assessed using Likert scale, and color stability was evaluated at baseline, 7, 15, and 30 days using Vita Lumin color scale. Statistical analysis was performed with Student's t-test, with $p<0.05$ considered significant.

Results: Smart monochromatic composites significantly reduced treatment time (8.11 ± 0.72 min vs. 10.36 ± 0.84 min, p=0.03) and yielded higher patient acceptance (4.6 ± 0.51 vs. 4.0 ± 0.00, p=0.001). Color stability was superior at all follow-up intervals ($p<0.05$).

Conclusion: Smart monochromatic composites offer enhanced clinical efficiency, better patient cooperation, and improved esthetic stability in pediatric anterior restorations. Their simplified application protocol makes them particularly valuable for child patients with limited attention spans. Longer-term studies are recommended to confirm durability and performance in posterior and multi-surface restorations.

Keywords: Color stability, multi-shade composite, Pediatric dentistry, Smart monochromatic composite, Restorative materials.

INTRODUCTION

Dental esthetics plays a pivotal role in the overall development of a child. Beyond restoring function, esthetic rehabilitation of primary teeth directly influences self-confidence, social interactions, and psychological well-being. Untreated anterior tooth decay or fractures can contribute to negative self-image, teasing, and social withdrawal [1]. Therefore, restorative dentistry in children requires not only functional integrity but also rapid and esthetic solutions tailored to the unique behavioral and physiological needs of this population.

Composite resins have long been favored for pediatric restorative procedures owing to their excellent esthetic outcome, minimal invasiveness, and adhesion to tooth structures. However, conventional multi-shade composites require meticulous shade selection, increasing procedure time and technique sensitivity [2]. This is particularly challenging in pediatric dentistry, where shorter appointments and simplified techniques are vital to ensure patient cooperation [3].

To overcome these limitations, manufacturers have introduced smart monochromatic composites. These innovative materials utilize advanced filler technology, allowing the restoration to blend seamlessly with surrounding tooth structure regardless of shade variations [4]. By eliminating the shade selection process and enabling bulk application, they potentially reduce operative time and enhance patient comfort [5].

While in vitro studies suggest favorable optical and mechanical properties of smart monochromatic composites, limited clinical evidence exists, particularly in pediatric populations. This randomized clinical trial compared the clinical performance, patient acceptance, and color stability of smart monochromatic versus conventional multi-shade composites in restorations of primary anterior teeth.

METHODS

This randomized clinical study was conducted in the Department of Pedodontics and Preventive Dentistry after obtaining institutional ethical clearance. Participants aged 4–9 years were selected because this developmental period corresponds to the presence of primary anterior teeth, which are commonly affected by caries and frequently require direct composite restorations for esthetic and functional rehabilitation. Children with systemic illness, poor oral hygiene, gross decay, or unmanageable behavior were excluded. Written informed consent was obtained from parents or guardians prior to enrolment.

The sample size was determined based on a pilot study and previous literature that reported differences in treatment duration and color stability between traditional composites and smart monochromatic composites. Assuming an effect size of 0.9, with a power of 80% and a significance level (α) of 0.05, the minimum sample size required was calculated as 18 teeth per group. To compensate for potential dropouts, the sample size was increased to 20 in each group, resulting in a total of 40 teeth included in the trial.

Participants were randomly assigned into two groups using a computer-generated randomization table. Group 1 (n=20) received restorations with traditional multi-shade composite resin (Te-Econom Plus, Ivoclar Vivadent, Liechtenstein) following shade selection, while Group 2 (n=20) was restored with smart monochromatic composite resin (Palfique Omnichroma, Tokuyama Dental Corp., Tokyo, Japan). All restorations were performed by a single calibrated operator to eliminate inter-operator variability. Standard protocols of etching with 37% phosphoric acid, bonding agent application, and light curing were followed for both groups. In the smart composite group, a bonding agent was

applied and light-cured, after which a blocker layer (0.5mm) was used to mask stains, lingual wall in larger Class III or Class IV preparations, followed by placement and curing of the smart monochromatic composite.

The primary outcomes were treatment duration, patient acceptance, and color stability. Treatment duration was recorded from the start of etching to the completion of polishing. Patient acceptance was evaluated using Likert scale during the procedure. Color evaluation was performed subjectively using the Vita Lumin color scale immediately after restoration, and subsequently at 7, 15, and 30 days." Data were analyzed using SPSS version 26. Student's t-test was applied for intergroup comparisons, with a p-value <0.05 considered statistically significant.

RESULTS

Comparison of the meantime duration (in minutes, presumably) between the Traditional Composite group and the Monochromatic Composite group. The mean time required for restorations using traditional composite was 10.36 ± 0.84 minutes, which was significantly higher compared to 8.11 ± 0.72 minutes for monochromatic composite restorations (p = 0.03). This demonstrates that monochromatic composites significantly reduce procedural time (Table 1).

Comparison of patient acceptance scores between the Traditional Composite group and the Monochromatic Composite group. The mean patient acceptance score was 4.0 ± 0.00 for the Traditional Composite group, indicating uniform responses among patients. In contrast, the Monochromatic Composite group showed a higher mean acceptance score of 4.6 ± 0.51, reflecting greater patient satisfaction with some variability in responses. The difference between the two groups was found to be statistically significant (p = 0.001), which is below the predefined significance level of p < 0.05. This result indicates that patients exhibited significantly higher acceptance of the Monochromatic Composite compared to the Traditional Composite material (Table 2).

Comparison of color alteration between the Traditional Composite and Monochromatic Composite groups at 7, 15, and 30 days. At 7 days, the Traditional Composite group exhibited a higher mean color alteration score (3.7 ± 1.94) compared to the Monochromatic Composite group (2.6 ± 1.23), with the difference being statistically significant (p = 0.03). At 15 days, a marked increase in color alteration was observed in the Traditional Composite group (5.85 ± 3.34), while the Monochromatic Composite group maintained a consistently lower mean score (2.6 ± 1.23), and this difference was highly statistically significant (p = 0.001). Similarly, at 30 days, the Traditional Composite group demonstrated the greatest color alteration (6.90 ± 4.10), indicating progressive discoloration over time, whereas the Monochromatic Composite group continued to show minimal color change (2.6 ± 1.23), with the intergroup difference remaining statistically significant (p = 0.001), suggesting superior color stability of monochromatic composites over the observation period (Table 3).

Table 1: Comparison of time duration between both the groups

Group	Mean ± SD	P value
Traditional Composite	10.36 ± 0.84	**0.03***
Monochromatic Composite	8.11 ± 0.72	

P<0.05 considered statistically significant

Table 2: Comparison of patient acceptance between both the groups

Group	Mean ± SD	P value
Traditional Composite	4.0 ± 0.00	**0.001***
Monochromatic Composite	4.6 ± 0.51	

P<0.05 considered statistically significant

Table 3: Comparison of Color alteration at different time periods between both the groups

Group		Mean ± SD	P value
7 days	Traditional Composite	3.7 ± 1.94	**0.03***
	Monochromatic Composite	2.6 ± 1.23	
15 days	Traditional Composite	5.85 ± 3.34	**0.001***
	Monochromatic Composite	2.6 ± 1.23	
30 days	Traditional Composite	6.90 ± 4.10	**0.001***
	Monochromatic Composite	2.6 ± 1.23	

P<0.05 considered statistically significant

DISCUSSION

The present study compared the clinical performance of smart monochromatic composites with traditional multi-shade composites in pediatric anterior restorations. The findings suggest that smart composites are advantageous in terms of reduced treatment time, better patient cooperation, and superior short-term color stability. The reduced treatment duration aligns with previous reports highlighting the clinical efficiency of shade-free composites [6]. In pediatric dentistry, minimizing chairside time is critical to reduce patient anxiety and improve cooperation [7].

Patient acceptance was also higher in the smart composite group. This observation supports the principles of behavior management, where shorter and simpler procedures contribute to more positive dental experiences [8]. Kusumawardani et al. [2] similarly reported higher satisfaction among children with simpler restorative approaches.

Color stability was markedly superior in smart composites. In vitro studies by AlHamdan et al. [3] and Ahmed et al. [4] have shown that filler technology in these composites resists discoloration from dietary pigments. A clinical trial by Zulekha et al. [5] also confirmed superior esthetics with smart composites in pediatric anterior teeth.

However, some studies have raised concerns regarding the mechanical performance of universal composites. While esthetic properties are favorable, long-term durability, wear resistance, and marginal adaptation may not be superior to conventional nanohybrid composites [9]. Moreover, most available data are based on in vitro simulations rather than clinical outcomes, highlighting the need for extended follow-up studies.

Certain authors also emphasize that color adaptation may vary depending on cavity depth, tooth translucency, and background shade, potentially limiting universal application [10]. In posterior restorations, occlusal load-bearing capacity remains a critical parameter that requires further evaluation [11].

The clinical efficiency and positive behavioral outcomes observed make smart composites highly suitable for pediatric anterior restorations. For clinicians managing anxious or uncooperative children, the reduction in operative steps may translate into improved treatment success.

The study was limited by its relatively short follow-up period. Longer-term clinical trials assessing survival rate, marginal adaptation, wear resistance, and secondary caries are necessary. Additionally, the sample size was modest, and future studies with larger cohorts and multi-center trials are warranted.

CONCLUSION

Smart monochromatic composites demonstrated superior clinical efficiency, higher patient acceptance, and improved short-term color stability compared to traditional multi-shade composites in pediatric anterior restorations. These findings support their potential role as an effective material in pediatric dentistry, simplifying restorative procedures while maintaining esthetic outcomes. Future long-term studies are recommended to confirm durability and expand applicability to posterior teeth.

Declaration by Authors
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