Original Article

Comparative Evaluation of Different Pediatric Medications on the Color Stability of Glass Ionomer and Composite Resin: An *In Vitro* Study

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Abstract

Background: In pediatric dentistry, esthetic restorative materials are often exposed to liquid medications, which may lead to staining and discoloration over time. **Aim:** To determine the effect of pediatric antibiotic (amoxicillin) and analgesic (paracetamol) syrups on the color stability of glass ionomer cements (GIC) and composite resin. **Materials and Methods:** An *in vitro* experimental design was employed. Disc-shaped samples of GIC and composite resin were prepared using Teflon molds. For the antibiotic group, 32 specimens of each material were used, while the analgesic group included 46 specimens per material. All samples were finished, polished, and baseline color values were recorded using a Vita EasyShade spectrophotometer. Specimens were then immersed in undiluted amoxicillin and paracetamol syrups for 7 days, with periodic agitation and storage in artificial saliva between immersions. Post-treatment color readings were taken, and color differences (ΔE) were calculated using the Commission Internationale de l'Éclairage Lab* system. Statistical analysis was done using the Kruskal–Wallis test and *post hoc* tests. **Results and Conclusion:** Composite resin displayed significantly more discoloration than GIC, particularly with antibiotic exposure. GIC showed better color stability, indicating its potential advantage in pediatric restorative cases involving long-term medication use.

Keywords: Color stability, Composite resin, Glass ionomer cement, *In vitro*, Pediatric medications, Spectrophotometry.

Introduction

Dental esthetics has emerged as a fundamental component of patient satisfaction, profoundly influencing self-perception by enhancing beauty and appeal.[1] The increasing demand for a naturally harmonious dental appearance has propelled extensive research into the innovation of advanced dental materials that meticulously emulate the properties of natural dentition.[2] The durability of these materials is evaluated based on their functional integrity and esthetic performance.[3]

Glass ionomer cements (GIC), compomers, and composites are the most frequently employed esthetic restorative materials in pediatric dentistry.[4] These materials are used for the restoration of both anterior and posterior teeth compromised by decay, facilitating the rectification of dental anomalies while augmenting overall esthetics. However, their long-term viability and clinical acceptability are predominantly contingent on their ability to retain color stability over time.[5]

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Pediatric medications, often formulated as syrups or suspensions, are routinely prescribed for children with acute or chronic illnesses.[6] The inherently low pH and elevated titratable acidity of these formulations pose potential risks, such as enamel erosion and intrinsic or extrinsic staining of both natural teeth and restorative materials.[7]

Considering these factors and the paucity of comprehensive studies in existing literature, the present research endeavors to systematically assess and compare the impact of various pediatric medications on the dynamics of color stability of esthetic restorative materials.

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Materials and Methods

This *in vitro* study was conducted in the Department of Pedodontics and Preventive Dentistry at the Index Institute of Dental Sciences.

The study involved the use of commonly prescribed pediatric liquid formulations. Two categories of drugs were selected: An antibiotic and an analgesic. The antibiotic used was amoxicillin, commercially available under the brand name Mox. The analgesic selected was paracetamol, marketed as Calpol. These medications were chosen due to their frequent administration in pediatric practice and their potential interaction with restorative dental materials.

Two widely used esthetic restorative materials were selected for evaluation. GIC was represented by Ketac™ Molar (3M ESPE, Germany), known for its fluoride release and chemical bonding properties. The composite resin used in the study was the A1 shade from Ivoclar Vivadent, chosen for its superior esthetics and commonly used shade in pediatric restorative procedures.

Statistical analysis plan

Data will be entered in Excel and analyzed using the Statistical Package for the Social Sciences v21.0 (IBM, Chicago). Normality will be tested using the Kolmogorov-Smirnov test.

This *in vitro* study was conducted in the Department of Pedodontics and Preventive Dentistry at the Index Institute of Dental Sciences, following standard laboratory protocols for restorative material testing.

Specimen preparation

A total of 32 GIC and Composite specimens (6 × 2 mm) were prepared for antibiotic testing, and 46 of each were fabricated for analgesic testing.

GIC specimens

Standardized disc-shaped Ketac™ Molar (3M ESPE, Germany) specimens (5 mm × 2 mm) were prepared using a lubricated cylindrical mold. The material was hand-mixed according to the manufacturer's instructions and placed into the mold over a Mylar strip on a glass slide. Second Mylar strip and glass slide were used to apply gentle pressure to ensure a flat surface. Specimens were allowed to set undisturbed for 7 min, after which they were carefully removed. Defective samples were discarded, and acceptable ones were stored in distilled water at 37°C for 24 h before testing.[8]

Table 1: Sample grouping

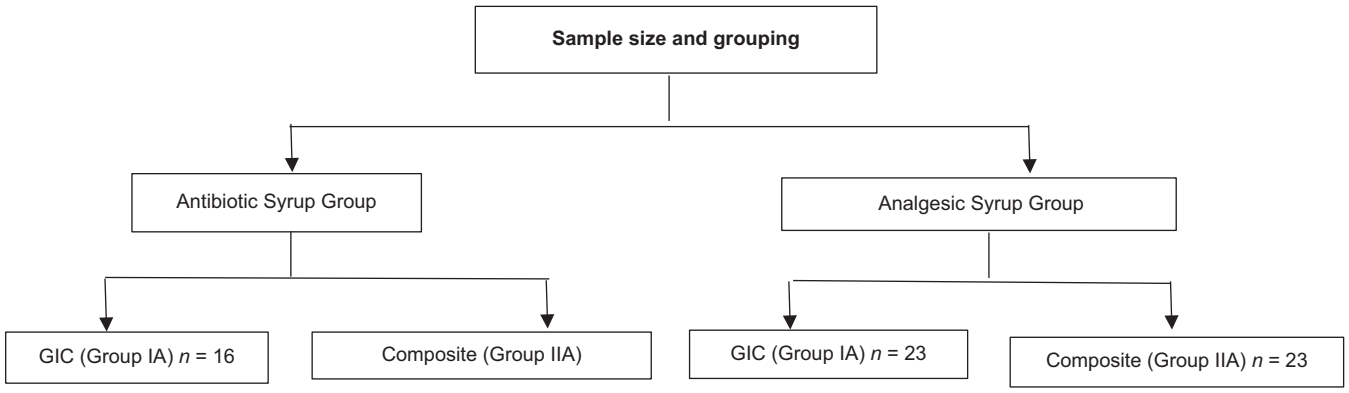

Table 2: Description of ΔE values among different groups

Groups	Mean ± standard deviation	Median (inter-quartile range)	Minimum	Maximum
Group IA	3.09±0.548	3.120 (2.840–3.415)	1.72	4.88
Group IB	2.47±0.745	2.440 (1.680–3.225)	1.22	3.49
Group IIA	6.48±0.493	6.610 (5.980–6.8575)	5.54	7.32
Group IIB	4.95±0.796	5.260 (4.5150–5.5525)	3.33	5.89

Table 3: Comparison of ΔE values between the groups

Groups	Median (inter-quartile range)	Mean rank	F*-value	*P*-value
Group IA	3.120 (2.840–3.415)	50.16	129.782	<0.001*
Group IB	2.440 (1.680–3.225)	33.14		
Group IIA	6.610 (5.980–6.8575)	133.11		
Group IIB	5.260 (4.5150–5.5525)	93.55		

Kruskal–Wallis test. *P<0.05 was considered statistically significant

Table 4: *Post hoc* analysis

Groups+	*P*-value
Group IA versus Group IIA	<0.001*
Group IB versus Group IIB	<0.001*
Group IA versus Group IB	0.102
Group II A versus Group IIB	<0.001*
Group IA versus Group IIB	<0.001*
Group IB versus Group IIA	<0.001*

*P<0.05 was considered statistically significant

Composite resin specimens

Composite resin discs (5 mm × 2 mm) were fabricated using Ivoclar Vivadent composite (A1 shade) and a Teflon mold. The composite was placed in a single increment, covered with a Mylar strip and glass slide to create a flat surface, and light-cured for 20 s using an LED curing unit (600 mW/cm^2). After curing, only defect-free specimens were selected and stored in distilled water at 37°C for 24 h to ensure complete polymerization.[9]

Specimen verification

Polished specimens were measured using a digital vernier caliper. Only those with dimensions of 5 ± 0.1 mm in diameter and 2 ± 0.1 mm in thickness were included in the study, as per standard dimensional criteria.[10]

Color measurement protocol

Initial color values (baseline) of all specimens were measured using a Vita EasyShade spectrophotometer (Ivoclar Vivadent, Liechtenstein), utilizing the Commission Internationale de l'Éclairage (CIE) Lab* color space system, which is well-established for dental color evaluations.[11]

Each specimen was immersed in 10 mL of undiluted pediatric medication – either Mox (amoxicillin) or Calpol (paracetamol) – contained in individual test tubes. Immersion involved manual agitation of the tubes for 2 min every 8 h for a 7-day period to simulate regular oral medication intake. Between immersion intervals, specimens were stored in artificial saliva at 37°C to mimic intraoral conditions.[12]

After the 7-day immersion period, all specimens were rinsed with distilled water, gently dried, and reassessed for color using the same spectrophotometric method. The color change (ΔE) was calculated using the CIE formula:

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

where:
ΔL = Change in lightness
Δa = Change in red-green value
Δb = Change in yellow-blue value.[13]

Results

This study assessed the color change (ΔE value) of restorative materials following exposure to pediatric drugs. With a median ΔE of 6.61, Group IIA (antibiotic composite) showed the largest color change of any group. Group IIB (antibiotic composite) came in second at 5.26, Group IA (antibiotic GIC) at 3.12, and Group IB (analgesic GIC) at 2.44.

This indicates that the materials discolored in the order listed below: Antibiotic composite > Analgesic composite > Antibiotic GIC > Analgesic GIC.

These differences were statistically significant, according to statistical analysis using the Kruskal–Wallis test ($P < 0.001$).

Group IA and Group IB, which were exposed to antibiotics and analgesics, did not vary significantly. Compared to analgesics (Group IIB), the composite in antibiotics (Group IIA) displayed noticeably higher discoloration. In comparison to their GIC counterparts (IA and IB), both composite groups (IIA and IIB) exhibited noticeably more discoloration. These findings imply that, in comparison to GIC restorations, composite restorations are more prone to discoloration, particularly when exposed to antibiotic syrups.

Discussion

This study evaluated the influence of commonly prescribed pediatric medications on the color stability of two restorative materials – GIC and composite resin. Both materials exhibited noticeable discoloration following immersion in the medications. Notably, composite resin demonstrated a higher degree of staining, particularly after exposure to amoxicillin syrup. These findings are consistent with the observations of Tüzüner *et al*.,[14] who emphasized the susceptibility of resin-based materials to discoloration due to their hydrophilic nature and weaker matrix-filler interface.

In contrast, Faghili *et al*.[15] reported that GIC experienced greater color changes, potentially attributed to its surface porosity, presence of microcracks, and dehydration effects, which can promote deeper penetration of staining agents. Additional support for these differences comes from Uctasli *et al*.[16] and Rueggeberg and Craig,[17] who noted that hydrophilic monomers in composite resins and inadequate bonding within the material structure lead to increased stain retention and reduced long-term esthetic stability.

Moreover, studies by Söderholm[18] and Valinoti *et al*.[19] highlighted that acidic and sugary formulations, such as those found in pediatric syrups, can erode composite surfaces. This degradation increases surface roughness, thereby enhancing pigment adherence and compromising esthetic outcomes over time. These changes may also impact the overall performance and longevity of restorations, making the selection of restorative materials critical in pediatric patients who require long-term restorations.

On the other hand, GIC was found to be relatively more resistant to staining, a property supported by research from Bagheri *et al*.[20] and Attia *et al*.[21] They attributed this resistance to the material's inorganic composition, lower water absorption, and the fluoride ions it releases, which can inhibit

plaque accumulation and maintain a smoother surface. These properties make GIC a more suitable choice in situations where esthetic preservation is important, particularly in high-risk pediatric cases with frequent medication use.

Although this *in vitro* study offers meaningful insights, its limitations must be acknowledged. The simulated conditions do not account for the dynamic variables present in the oral environment, such as the effects of saliva, toothbrushing, dietary habits, and fluctuating temperatures. Furthermore, the short duration of immersion (7 days) may not accurately reflect the long-term impact of repeated medication use on restorative material discoloration. Future *in vivo* studies with extended observation periods and varied clinical conditions would provide a more comprehensive understanding of how these materials perform under real-world usage.

Conclusion

This study highlights practical choices in pediatric dentistry. GIC is preferable in non-stress areas for children on long-term syrups due to better color stability. Composite resin suits high-stress areas for its strength, though potential staining should be discussed with parents. Future studies should include longer durations, real oral conditions, more medications, and explore protective coatings to reduce discoloration.

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