EFFECT OF DEPTH ON THE COLOR ADAPTATION OF SINGLE-SHADE RESIN COMPOSITES IN LIGHT SUBSTRATES

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1. INTRODUCTION

The pursuit of highly aesthetic restorative materials has driven innovation in composite resins, particularly those designed to simplify the clinical workflow (PARAVINA et al, 2019). Achieving an ideal color match in restorative dentistry remains challenging due to the optical complexity of natural teeth (FAVORETO et al, 2024). Single-shade resin composites have emerged as a promising solution, offering a single material to blend with various dental shades through the so-called "chameleon effect." This blending capacity aims to reduce the time and complexity of shade selection (FIDAN et al, 2023; ZHU et al., 2023).

The single-shade materials use the principle of structural color, wherein nanometric filler particles selectively reflect light to blend with the dental substrate, unlike conventional multi-shade composites that rely on chemical pigments to reproduce specific shades (AHMED et al, 2022; BROWN et al, 2019). Although in vitro studies indicate that factors such as filler particle size and distribution, resin matrix composition, and substrate characteristics influence the color adjustment potential of these materials (SUH et al, 2017; AKGÜL et al, 2022).

Clinical evidence regarding the performance of this material remains limited and often inconclusive (NAGI et al, 2022; KORKUT et al, 2023). Furthermore, some variables seem to influence the color adaptation of the material, such as depth and color of the substrate, since darker substrates or deeper preparations may compromise the material's ability to mask underlying discolorations, directly affecting the esthetic outcome (PEREIRA SANCHEZ et al, 2019). Moreover, the polychromatic nature of natural teeth, with variations in translucency, opacity, and hue across different regions, presents an additional challenge for single-shade materials, highlighting the need for studies assessing their performance under diverse clinical and laboratory conditions (BATISTA et al., 2023; OIVANEN et al., 2021). To contribute to filling the gaps in the literature regarding this material, this study aims to assess the color-matching performance of single-shade resin composites compared to conventional multi-shade composites in bovine incisor restorations, with a particular emphasis on light tooth shades and varying cavity depths.

2. METHODOLOGY

2.1 Restorative Procedures

The single-shade resin composites Omnichroma (Tokuyama, Tokyo, Japan) and Vittra Unique (FGM, Joinville, Santa Catarina, Brazil) were evaluated. As a multi-shade control, Vittra APS (FGM, Joinville, Santa Catarina, Brazil) was used. For each bovine tooth (n=30), a condensation silicone matrice (Yller REFLEX, Brazil) were fabricated for the cervical third, aiming to guide the color coordinate readings with the VITA Easyshade spectrophotometer (VITA Zahnfabrik, Germany). Perforations were made with a 6 mm biopsy punch (Uniqmed, Brazil) at the indicated thirds to properly adapt the spectrophotometer tip. Prior to tooth preparation, baseline color readings were performed at the cervical third with the spectrophotometer. Circular cavities measuring 6 mm in diameter with depths of 1.5 mm and 3 mm were created using a PM diamond bur (PM019, American Burrs, Brazil). Following the dental preparations, a color reading was performed in the cervical third using a spectrophotometer. The tested composite resins were handled according to the manufacturer's instructions. The material was light-cured with the LED light-curing unit Valo Cordless Grand 3200 (Ultradent) for 20 seconds. After completing the restoration, finishing and polishing were carried out using the Twist Gloss spiral system (American Burrs, United States).

2.3 Instrumental and Visual analysis

Baseline measurements were performed after the sample was finished and polished. Readings were performed in the cervical thirds using a previously prepared silicone guide. For each tooth, the CIE L*ab** color parameters were determined in triplicate at the following time points: before the cavity preparation in the cervical third, after cavity preparation in the cervical third, and after dental restoration in the cervical third. A VITA Easyshade spectrophotometer (VITA Zahnfabrik, Germany) was used, calibrated before each measurement according to the manufacturer's instructions. Color differences (ΔE) between restoration and tooth were calculated using the CIEDE2000 formula (SHARMA, WU & DALAL, 2005). For the visual analysis, the color adaptation of the restorations was classified according to the pre-established FDI parameters as clinically satisfactory or clinically unsatisfactory (HICKEL et al., 2023).

2.4 Statistical Analysis

The results of color adaptation were tabulated and subsequently analyzed using SigmaPlot 12.0 software. The normality and homogeneity of variance of the sample were assessed using the Shapiro-Wilk and Levene tests. Subsequently, One-Way ANOVA Wallis test was performed. Tukey's post-hoc test was used to analyze differences between groups at a significance level of 5%.

3. RESULTS AND DISCUSSION

3.1 Instrumental Analysis

Table 1. Color evaluation (ΔE) in light-shaded teeth according to resin, depth, and region (cervical third).

Resin	Depth (mm)	Light-shaded teeth ΔE Cervical Third (Mean ± SD)
Vittra Unique	1.5	10.0 ± 2.0^{AB}
	3.0	12.0 ± 3.2^{A}
Omnichroma	1.5	5.9 ± 2.3^{BC}
	3.0	10.9 ± 0.5^{A}
Vittra APS*	1.5	5.1 ± 3.1^{C}
	3.00	5.3 ± 1.9^{C}

*For light-shaded teeth it was used the EA1 and DA1.
One Way-ANOVA followed by Tukey's test. Different letters in the same column indicate statistically significant differences between groups ($p<0.05$)

3.2 Visual Analysis

Table 2. Visual evaluation in light-shaded teeth according to resin, depth, and region (cervical third).

Resin	Depth (mm)	Light-shaded teeth Visual Evaluation Scores (Mean ± SD)
Vittra Unique	1.5	1.40 ± 0.89
	3.0	1.80 ± 0.84
Omnichroma	1.5	1.6 ± 0.55
	3.0	0.6 ± 0.55
Vittra APS*	1.5	2.0 ± 1.58
	3.00	1.4 ± 1.14

*For light-shaded teeth it was used the EA1 and DA1.
One Way-ANOVA. No differences betweens groups were found ($p>0.05$)

The present study assessed the color-matching ability of two single-shade composite resins, Omnichroma and Vittra Unique, when applied in class V cavities prepared in bovine teeth with light substrates at different depths. The instrumental analysis revealed that darker substrates and increased cavity depth negatively affected color adaptation, especially for Omnichroma. These findings are consistent with previous investigations showing that increased depth can reduce the effectiveness of the blending effect in single-shade composites, likely due to reduced light reflection and scattering from the underlying substrate (FERNANDES-E-SILVA et al., 2024). In particular, the instrumental values frequently exceeded the pre-established acceptability threshold of $\Delta E_{00} = 1.8$, suggesting that these resins may not produce clinically acceptable results under such conditions. This threshold has been widely accepted in dental literature as a benchmark for perceptibility and acceptability of color differences (PARAVINA et al., 2019).

4. CONCLUSIONS

Based on the instrumental analysis, in light-shaded teeth, only Omnichroma at a 1.5 mm depth demonstrated color matching comparable to the multishade resin Vittra APS. Both Vittra Unique at 1.5 mm and 3 mm depths, as well as Omnichroma at 3 mm, exhibited inferior color adaptation compared to the multishade controls. In the visual analysis, no significant differences were found between groups across different depths.

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