coatings

MDPI

Article

Influence of Modeling Liquids and Universal Adhesives Used as Lubricants on Color Stability and Translucency of Resin-Based Composites

Gaetano Paolone [1,*], Claudia Mazzitelli [2], Giacomo Zechini [1], Salvatore Scolavino [3], Cecilia Goracci [4], Nicola Scotti [5], Giuseppe Cantatore [1], Enrico Gherlone [1] and Alessandro Vichi [6]

1 Department of Dentistry, IRCCS San Raffaele Hospital and Dental School, Vita Salute University, 20158 Milan, Italy
2 Dipartimento di Scienze Biomediche e Neuromotorie (DIBINEM), University of Bologna, 40125 Bologna, Italy
3 Independent Researcher, 80035 Nola, Italy
4 Department of Medical Biotechnologies, University of Siena, 53100 Siena, Italy
5 Department of Surgical Sciences, Dental School Lingotto, University of Turin, 10126 Turin, Italy
6 Dental Academy, University of Portsmouth, William Beatty Building, Hampshire Terrace, Portsmouth PO1 2QG, UK
* Correspondence: paolone.gaetano@hsr.it; Tel.: +39-02-2643-2970

Abstract: The use of lubricants during restorative procedures is a clinically common practice to alleviate the stickiness of resin-based composite (RBCs) materials and to improve its handling. This study evaluated the effects of three modeling liquids (ML) and one universal adhesive (UA) used as lubricants during composite layering on the color stability and translucency of RBCs. Methods. The following materials were applied between every 1 mm RBC layer (total restoration height of 4 mm): GC modeling liquid (GCML, GC Corporation, Tokyo, Japan), composite wetting resin (UPWR, Ultradent Products, South Jordan, UT, USA), Bisco modeling resin (BSMR, Bisco Inc., Schaumburg, IL, USA) as an ML and Clearfil Universal Bond Quick (KUBQ, Kuraray Noritake Dental, Tokyo, Japan) as a UA. Lubricant-free specimens were used as the control. Color coordinates (L^*, a^* and b^*) were recorded at baseline and after a simulation of 1 month of coffee consumption. Data were analyzed using ANOVA and a post hoc Tukey test ($p < 0.05$). Results. All lubricants induced a color change higher than the perceptibility threshold ($\Delta E00 > 0.81$). GCML showed the highest color stability. The use of KUBQ resulted in significantly higher a^* values ($p = 0.001$) at baseline and after staining. KUBQ and UPWR significantly influenced the color stability ($\Delta E00$, $p = 0.0001$) after staining, overcoming the clinical acceptability threshold ($\Delta E00 > 1.77$). Conclusions. The use of lubricants may affect color stability at baseline and after simulation of staining. Translucency was not affected at baseline nor after staining. Clinical Significance. Clinicians should be aware that some lubricants may affect color stability, even at baseline.

Keywords: modeling liquid; modeling resin; lubricant; resin-based composite; color stability; translucency; staining

check for updates

Citation: Paolone, G.; Mazzitelli, C.; Zechini, G.; Scolavino, S.; Goracci, C.; Scotti, N.; Cantatore, G.; Gherlone, E.; Vichi, A. Influence of Modeling Liquids and Universal Adhesives Used as Lubricants on Color Stability and Translucency of Resin-Based Composites. *Coatings* **2023**, *13*, 143. https://doi.org/10.3390/coatings13010143

Academic Editor: Binjia Zhang

Received: 23 December 2022
Revised: 4 January 2023
Accepted: 9 January 2023
Published: 11 January 2023

1. Introduction

Resin-based composites (RBCs) are commonly used for direct restorations as they provide optimal esthetics [1,2] for a long period of time [3,4]. Satisfactory esthetic outcomes depend both on the clinician's skills and materials' properties [5]. Among the latter, handling is pivotal in providing the clinicians with the capability to apply RBCs in different shades. The stickiness of RBCs to the modeling instruments can be a clinical drawback, as it may affect the quality of layering and sculpting during the restorative procedures [6]. Indeed, certain RBCs can stick to the modeling instruments or brushes, limiting the possibility of properly reproducing the anatomy of the affected or missing parts of the tooth. To overcome this problem, many clinicians have used low viscosity materials such as dental bonding agents (DBA), which are used to wet the instrument in order to reduce the surface tension of the composite and therefore facilitating modeling [7–9]. The use of DBA as a modeling agent has increased over time among clinicians, as it is a low viscosity resin available on the operative tray, thus not requiring additional materials [6,9]. Likewise, some manufacturers have marketed dedicated modeling liquids (ML). ML, also known as modeling resins, modeling agents or wetting agents, are unfilled resins generally comprising of methacrylates such as urethane dimethacrylate (UDMA), bisphenol A-glycidyl methacrylate (Bis-GMA) and triethylene glycol dimethacrylate (TEGDMA) [6]. They are therefore mainly composed of hydrophobic non-solvated resins with low or no organic fillers. Whether "generic" dental DBA or "on-purpose" ML are used, concerns about possible negative effects on the mechanical and optical properties have arisen [9,10]. It has been reported that mechanical properties could be improved when a hydrophobic unfilled resin was used between restoration layers [9–11]. This effect has been related to the reduction in defects and voids between restoration layers following the layering procedure. Conversely, when more hydrophilic DBAs were used as lubricants, they have exhibited poorer mechanical properties and a more prominent color change [9–11]. Moreover, the effect of the application of a DBA on the surface may affect material conversion and may provide a poor cross-linked polymer network [12]. The application of a lubricant (DBA or ML) may alter superficial RBC composition, increasing the monomer ratio in relation to the filler, and therefore increasing liquid/colorant sorption [13]. The hydrophilic characteristics of monomers, as well as the solvents contained in the solvated DBA, may in fact lead to an increase in staining pigment absorption and to color instability over time [13]. More recently, universal adhesives (DBA-UA) that contain solvents and hydrophilic monomers have been gaining popularity among clinicians due to their versatility and ease of use, progressively replacing the older DBAs formulations. However, scientific evidence about the use of UA as lubricants and their effect on mechanical and optical properties is scarce and controversial [7,8].

From a clinical point of view, an alteration in optical properties could be detrimental for the final esthetic outcome. Therefore, the aim of the present study was to evaluate the influence of ML or UA on color stability and translucency of a nano-hybrid RBC. The null hypotheses tested were: (i) ML or UA do not affect color coordinates of RBC at baseline; (ii) ML or UA do not affect color change of RBC; and (iii) ML or UA do not affect translucency of RBC.

2. Materials and Methods

One RBC (Clearfil Majesty Es-2 Classic, Kuraray Noritake Dental Inc, Tokyo, Japan) was used as the restorative material. Three modeling liquids (GC modeling liquid, GC Corporation, Tokyo, Japan, GCML; Composite Wetting Resin, Ultradent Products, South Jordan, UT, USA, UMWR; Bisco Modeling Resin, Bisco Inc, Schaumburg, IL, USA, BSMR) and one universal adhesive (Clearfil Universal Bond Quick, Kuraray Noritake Dental Inc, Tokyo, Japan, KUBQ) were used (n = 12). Complete information of the materials used in this study is presented in Table 1. One additional group (n = 12) was prepared without the application of intra-layer lubricant and served as the control group. A total of 60 specimens were therefore prepared.

Every specimen was prepared by a single operator by placing four increments (0.5 mm each) of RBC using a steel template with a micrometer screw for controlling the thickness (Ceramic Sampler, Smile Line, Saint-Imier, Switzerland). Specimens manufactured with ML or UA were prepared as follows: After the placement of the first composite increment, before light-curing, the modeling resin was applied on the composite surface with a disposable brush (Microbrush® International, Grafton, WI, USA). After light-curing with a LED light-polymerization unit (VALO, Ultradent Products, Suth Jordan, UT, USA) with 1000 mW/cm^2 for 20 s, the steel template was adjusted to allow the placement of a 0.5 mm layer. After the application of the modeling liquid on the fourth (and last) increment of composite, a mylar strip and a glass slide were applied before light curing. The bottom surface as well as the lateral one of all the cylindric specimens was coated with a transparent nail varnish (Classic Nail Enamel, Clear, Revlon, New York, NY, USA) leaving the top surface (last layer applied) uncovered. The samples were stored in distilled water for 24 h at 37 °C to allow post-curing. Control group specimens were produced as described but no lubricant was used between increments.

Table 1. Products, manufacturers, compositions and lots.

Lubricants			
Product	**Manufacturer**	**Composition**	**Lot**
GC Modeling liquid	GC Corp., Tokyo, Japan	Urethane dimethacrylate (UDMA), 2-hydroxy-1,3 dimethacryloxypropane 2-hydroxyethyl metacrylate and 2-hydroxy-1,3 dimethacryloxypropane	2107071
Composite Wetting Resin	Ultradent Products, South Jordan, USA	Triethylene, glycol dimethacrylate, diurethane dimethacrylate, silane and butylated hydroxytoluene	BH836
Clearfil Universal Bond Quick	Kuraray, Noritake, Japan	MDP, bis-GMA, HEMA, hydrophilic amide monomers, colloidal silica, silane coupling agent, sodium fluoride, dl-camphorquinone, ethanol and water.	220289
Modeling Resin	BISCO, Schaumburg, USA	UDMA (20–40), amorphous silica (20–40), bis-EMA (10–30), TEGDMA (5–20) and bis-G- MA (1–10)	2100000881

2.1. Color Measurements

Color coordinates, L^*, a^* and b^*, of the CIELab color system, and C^* of CIELCH color system were obtained using a digital spectrophotometer (Vita Easyshade, Vita Zahnfabrik, Bad Säckingen, Germany) on a gray background ($L^* = 79$, $a^* = 0$ and $b^* = 0$). Calibration was performed as indicated by the manufacturer at the beginning and after each group ($n = 12$) measurement. All measurements were performed by a single trained operator with standardized D65 light room illumination. Three readings were performed for each specimen and the mean values of color coordinates were obtained. Color measurements were performed before (t0) and after (t1) immersion in the staining solution.

2.2. Staining Procedure

The staining procedure was performed with coffee since it is the most standardizable liquid colorant and the most investigated [13]. To prepare the staining solution, 24 g of coffee powder (Nescafé Classic, Nestlé Italia, Assago, Italy) was poured into 2 L of boiling distilled water [13]. After 10 min of stirring, the coffee solution was filtered through filter paper. The staining solution was kept at 44° ± 1°C [14]. Specimens were immersed in the staining solutions for 24 h, corresponding to a coffee consumption of 1 month [15]. The staining solution was renewed every 6 h.

2.3. Translucency

Specimen translucency was calculated using the translucency parameter (TP) and contrast ratio (CR). TP was calculated using the formula:

$$TP = \sqrt[2]{(L^*_B - L^*_W)^2 + (a^*_B - a^*_W)^2 + (b^*_B - b^*_W)^2} \quad (1)$$

where the W refers to the CIELab values on a white background, while "B" refers to the CIELab values on a black background.

The L^* coordinates values measured on white and black backgrounds were also used to calculate the luminance from Color Space CIEXYZ as follows:

$$Y = \left(\frac{L + 16}{116}\right)^3 \times Y_n \quad (2)$$

Y values of the specimens recorded on white (Y_W) and black (Y_B) backgrounds were used to calculate the Contrast Ratio (CR) as follows:

$$CR = \frac{Y_B}{Y_W} \quad (3)$$

TP and CR were calculated before (t0) and after (t1) the staining procedure.

2.4. Color Differences

To evaluate color differences, the CIEDE2000 (ΔE00) formula was used according to the following equation [16,17]:

$$DE_{00} = \left[\left(\frac{\Delta L'}{K_L S_L}\right)^2 + \left(\frac{\Delta C'}{K_C S_C}\right)^2 + \left(\frac{\Delta H'}{K_H S_H}\right)^2 + R_T\left(\frac{\Delta C'}{K_C S_C}\right)^2\left(\frac{\Delta H'}{K_H S_H}\right)^2\right]^{1/2} \quad (4)$$

where $\Delta L'$, $\Delta C'$ and $\Delta H'$ are the differences in lightness, chroma and hue for a pair of specimens using CIEDE2000, respectively. SL, SC and SH are weighting functions for adjustment of the total color difference for the variation in perceived magnitude with variation in the location of the color coordinate difference between two color measurements. Parametric factors K_L, K_C and K_H in the CIEDE2000 formula were set to 1.

Color differences were also evaluated through comparisons with 50:50% perceptibility (PT) and 50:50% acceptability (AT) thresholds. Considered PT and AT values for CIEDE2000 (1:1:1) were 0.81 and 1.77 [18], respectively.

2.5. Statistical Analysis

The Shapiro–Wilk method was applied to test the normality of all response variables.

In order to evaluate possible differences among the investigated groups, a one-way ANOVA was used for the factor "modeling liquid" for every color parameter (L^*, a^* and b^*) and for differences (ΔL^*, Δa^*, Δb^*, ΔE00, ΔTP and ΔCR) between baseline (t0) and staining (t1). A post hoc Tukey test was used to identify the differences between groups. A significance level of 95% was applied.

3. Results

The results of color and translucency parameters at baseline and after staining are reported in Table 2. No statistically significant differences were found for L^* ($p = 0.122$), b^* ($p = 0.289$), TP ($p = 0.335$) or CR ($p = 0.442$) measured at baseline, nor for L ($p = 0.107$), TP ($p = 0.450$) or CR ($p = 0.520$) after staining. Significant differences were reported for a^* ($p < 0.001$) at baseline and for a^* ($p < 0.0001$) and b^* ($p < 0.0001$) after the staining procedure. KUBQ showed significantly higher a^* values at baseline and after staining. KUBQ and UPWR showed significantly higher b^* values after staining.

Table 3 presents the changes in color parameters (ΔL^*, Δa^*, Δb^*, ΔE00, ΔTP and ΔCR). No significant differences were reported for changes in L^* ($p = 0.154$), TP ($p = 0.651$) or CR ($p = 0.745$). Significant differences in color change (ΔE00, $p = 0.0001$) and in changes of a^* ($p = 0.001$) and b^* ($p = 0.0001$) parameters were reported. KUBQ and UPWR induced a significantly higher color change than the other investigated lubricants or the control group. Figure 1 shows a specimen before and after the staining procedure. Figure 2 shows a chart representing the color change obtained after the staining procedure for the investigated groups.

Table 2. Means and standard deviation the color parameters at baseline (t0) and after staining (t1) procedures (n = 12). Distinct letters in columns indicate statistical difference ($p < 0.05$).

Material	L^*_{t0}	L^*_{t1}	a^*_{t0}	a^*_{t1}	b^*_{t0}	b^*_{t1}	TP_{t0}	TP_{t1}	CR_{t0}	CR_{t1}
Control	73.70 ± 1.20^{A}	72.51 ± 1.09^{A}	$0.97 \pm 0.34^{A,B}$	$1.14 \pm 0.35^{A,B}$	26.87 ± 1.47^{A}	$28.41 \pm 1.23^{A,B}$	8.81 ± 1.27^{A}	8.25 ± 1.07^{A}	0.85 ± 0.02^{A}	0.86 ± 0.02^{A}
GCML	73.20 ± 1.28^{A}	72.12 ± 1.37^{A}	0.84 ± 0.29^{A}	$1.14 \pm 0.27^{A,B}$	26.42 ± 0.87^{A}	27.42 ± 0.85^{A}	9.39 ± 1.56^{A}	8.68 ± 1.71^{A}	0.84 ± 0.03^{A}	0.85 ± 0.03^{A}
UPWR	73.44 ± 1.15^{A}	72.21 ± 0.88^{A}	$1.10 \pm 0.35^{A,B}$	$1.49 \pm 0.28^{B,C}$	27.20 ± 0.94^{A}	30.48 ± 1.10^{C}	8.84 ± 0.82^{A}	8.37 ± 0.86^{A}	0.85 ± 0.02^{A}	0.86 ± 0.02^{A}
KUBQ	73.83 ± 0.57^{A}	72.11 ± 0.76^{A}	1.35 ± 0.44^{B}	1.57 ± 0.40^{C}	27.21 ± 0.90^{A}	29.98 ± 0.89^{C}	8.38 ± 1.09^{A}	7.83 ± 0.88^{A}	0.86 ± 0.02^{A}	0.87 ± 0.02^{A}
BSMR	72.78 ± 0.92^{A}	71.38 ± 0.87^{A}	0.80 ± 0.25^{A}	0.93 ± 0.24^{A}	26.69 ± 0.90^{A}	28.69 ± 0.95^{B}	8.79 ± 0.81^{A}	8.19 ± 0.70^{A}	0.85 ± 0.02^{A}	0.86 ± 0.01^{A}

Table 3. Means and standard deviation the color parameters at baseline (t0) and after staining (t1) procedures (n = 12). Distinct letters in columns indicate statistical difference ($p < 0.05$).

Material	ΔL^*	Δa^*	Δb^*	$\Delta E00 \pm DS$	ΔTP	ΔCR
Control	1.19 ± 0.27^{A}	-0.17 ± 0.11^{B}	$-1.54 \pm 0.66^{C,D}$	1.15 ± 0.27^{A}	-0.56 ± 0.35^{A}	0.01 ± 0.01^{A}
GCML	1.08 ± 0.97^{A}	$-0.30 \pm 0.23^{A,B}$	-1.00 ± 0.72^{D}	1.11 ± 0.60^{A}	-0.70 ± 0.50^{A}	0.01 ± 0.01^{A}
UPWR	1.23 ± 0.97^{A}	-0.39 ± 0.20^{A}	-3.28 ± 0.87^{A}	1.80 ± 0.61^{B}	-0.47 ± 0.32^{A}	0.01 ± 0.01^{A}
KUBQ	1.73 ± 0.34^{A}	$-0.22 \pm 0.12^{A,B}$	$-2.76 \pm 0.27^{A,B}$	1.79 ± 0.18^{B}	-0.55 ± 0.35^{A}	0.01 ± 0.01^{A}
BSMR	1.39 ± 0.30^{A}	-0.13 ± 0.09^{B}	$-2.01 \pm 0.61^{B,C}$	$1.41 \pm 0.22^{A,B}$	-0.60 ± 0.37	0.01 ± 0.01^{A}

(**a**) (**b**)

Figure 1. UPWR composite specimen before (**a**) and after (**b**) the staining procedure.

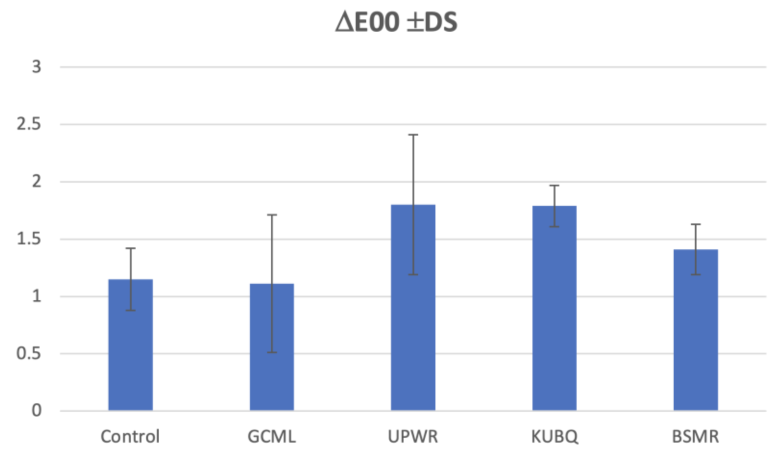

Figure 2. Color change (and standard deviation) obtained after the staining procedure for the investigated groups.

4. Discussion

RBCs have allowed the application of esthetically pleasant direct restorations with minimally invasive procedures [19]. To improve handling and reduce their stickiness, some clinicians use lubricants (ML or DBA) to reduce surface tension [20]. The clinical procedure consists of wetting dental composite instruments or brushes, allowing for the production of smooth surfaces. The use of these lubricants has raised several concerns over whether their influence could lead to an alteration in RBC properties, among which include color properties. In the present study, significant differences were reported for single color coordinates (*a** at baseline and *a** and *b** after the staining procedure) and for color change (ΔE00); therefore, hypothesis #i and #ii must be rejected.

Conflicting results are available in the literature. The present study is in accordance with Kutuk et al. [7], who reported that a specific ML (Modeling Liquid, GC Corp) provided more color stability than a UA (G-Premio Bond, GC Corp.). In the present study, similar results were reported with GCML, which provided the highest color stability compared to the control group. Araujo et al. [8] reported that a UA (Adper Universal, 3M ESPE) showed more color stability than a non-solvated adhesive (3-step ER; Adper Scotchbond Multipurpose). The authors related the higher color stability to differences in viscosity between the two investigated adhesives. Conversely, in the present study, UPWR and KUBQ showed significantly higher color changes with respect to the control group and GCML. BSMR showed higher ΔE00 values, but differences were not significant from the control group. Our findings are also in accordance with Pereira et al. [21], who did not report differences between the same modeling resin (BSMR) and control group after red wine staining ($7' \times 7$ d).

In the present study, statistically significant differences were observed for the *a** color coordinate (red-green axis) at baseline. Specimens treated with KUBQ at baseline showed in fact significantly higher *a** values with respect to GCML and BSMR, suggesting a color shift towards red. After the staining procedure, KUBQ showed significant differences in this color coordinate with respect to all the other investigated groups. This behavior suggests that the use of UA might favor a larger color shift towards red. This is probably related to UA's composition, which is generally characterized by components susceptible to water/stain absorption such as hydrophilic monomers, HEMA and water [8,22]. Araujo et al. [8] reported that the color change induced using lubricants was mainly influenced by an increase in the *L** coordinate (lightness), while staining substances decrease *L**. In the present study, no statistical differences were reported for the *L** coordinate at baseline and after staining. Despite that in our study no significant differences in the *b** coordinate (blue-yellow) were observed at baseline, KUBQ, UPWR and BSMR reported significantly higher *b** values than GCML after staining. GCML later showed a tendency to lower the change in b value (although not significantly) compared to the control group. According to the result of the present study, all the investigated lubricants, except GCML, may increase the yellowish appearance of a restoration with time. Specimens modeled with UPWR and KUBQ showed, after artificial staining, a color change (ΔE00 values) that was statistically significantly higher than the control group and GCML. These differences could be related to the presence of UDMA in the latter. UDMA is in fact reported to be more resistant to color change with respect to bis-GMA [23]. UDMA-based RBCs indeed generally show lower water sorption [24] and higher color stability [23].

Although statistical analysis was applied to evaluate the significant differences between groups, it is important to understand whether the behavior of the investigated materials has clinical implications. Perceiving a difference and whether this difference is clinically acceptable is of paramount importance. For this purpose, color change is based on two major thresholds: perceptibility threshold (PT) and acceptability threshold (AT) [25,26]. The 50:50% PT and 50:50% AT in CIEDE2000 were 0.81 and 1.77, respectively. After simulation of one month staining, all investigated materials showed perceivable differences. However, clinically unacceptable values (>1.77) were reported only for UPWR and KUBQ. Color change has a detrimental effect on dental treatment, especially if they are performed in esthetic areas. Despite the fact that color change cannot be avoided, Paolone et al. [13] reported that a possible reduction in the color change caused by staining may be obtained by repolishing procedures that are not always able to revert the color change within the color acceptability thresholds.

In the present study, no significant difference in translucency (TP or CR) was observed between groups at baseline or after staining. Therefore, hypothesis #iii has to be accepted. This finding has a clinical relevance, as the use of lubricants will not affect the restorative material translucency that is pivotal for the esthetic success [27–29]. Such a finding is in accordance with Araujo et al. [8], who reported a significant change in translucency after a 2 month staining simulation in the oral cavity, with a significantly lower change in opacity for specimens treated with a Universal Adhesive (Adper Universal, 3M ESPE). Conversely, Melo et al. reported significant differences in translucency (TP) at baseline for three investigated composites (Filtek Z350XT, 3m Espe; Empress Direct, Ivoclar Vivadent, Esthet X HD, Dentsply Sirona) for bleach shades and for two composites (Filtek Z350XT, 3m Espe; Empress Direct, Ivoclar Vivadent) for the A2 shade. The limitations of our study are that immersion in the liquids was static and not thermocycled. Furthermore, no brushing simulation was involved in the present study.

5. Conclusions

Within the limitations of this in vitro study, some conclusions can be drawn:

- The use of KUBQ significantly increases the a^* color coordinate values (reddish) at baseline;
- UPWR and KUBQ led to an unacceptable clinical color change after a 1-month artificial staining simulation;
- The use of the investigated lubricants did not influence translucency (TP and CR) at baseline or after the 1-month artificial staining simulation;
- Clinicians should take into consideration that color change may occur during the clinical service of the resin-based restorations; therefore, they should warn patients of this possible drawback.

Author Contributions: Conceptualization, G.P. and A.V.; methodology, G.P.; software, G.P.; validation, S.S., C.G., C.M., N.S., E.G. and G.C.; formal analysis, G.P.; investigation, G.Z.; resources, G.P.; data curation, G.P.; writing—original draft preparation, G.P.; writing—review and editing, G.P and A.V.; visualization, C.M.; supervision, E.G.; project administration, G.P. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Manauta, J.; Salat, A.; Putignano, A.; Devoto, W.; Paolone, G.; Hardan, L.S. Stratification in Anterior Teeth Using One Dentine Shade and a Predefined Thickness of Enamel: A New Concept in Composite Layering—Part I. *Odonto-Stomatol. Trop. Trop. Dent. J.* **2014**, *37*, 5–16.
2. Manauta, J.; Salat, A.; Putignano, A.; Devoto, W.; Paolone, G.; Hardan, L.S. Stratification in Anterior Teeth Using One Dentine Shade and a Predefined Thickness of Enamel: A New Concept in Composite Layering—Part II. *Odonto-Stomatol. Trop. Trop. Dent. J.* **2014**, *37*, 5–13.
3. Demarco, F.F.; Collares, K.; Coelho-de-Souza, F.H.; Correa, M.B.; Cenci, M.S.; Moraes, R.R.; Opdam, N.J.M. Anterior Composite Restorations: A Systematic Review on Long-Term Survival and Reasons for Failure. *Dent. Mater.* **2015**, *31*, 1214–1224. [CrossRef]
4. Opdam, N.J.M.; van de Sande, F.H.; Bronkhorst, E.; Cenci, M.S.; Bottenberg, P.; Pallesen, U.; Gaengler, P.; Lindberg, A.; Huysmans, M.C.D.N.J.M.; van Dijken, J.W. Longevity of Posterior Composite Restorations: A Systematic Review and Meta-Analysis. *J. Dent. Res.* **2014**, *93*, 943–949. [CrossRef] [PubMed]
5. Paolone, G. Direct Composite Restorations in Anterior Teeth. Managing Symmetry in Central Incisors. *Int. J. Esthet. Dent.* **2014**, *9*, 12–25. [PubMed]
6. Paolone, G.; Mazzitelli, C.; Josic, U.; Scotti, N.; Gherlone, E.; Cantatore, G.; Breschi, L. Modeling Liquids and Resin-Based Dental Composite Materials—A Scoping Review. *Materials* **2022**, *15*, 3759. [CrossRef] [PubMed]

7. Kutuk, Z.B.; Erden, E.; Aksahin, D.L.; Durak, Z.E.; Dulda, A.C. Influence of Modeling Agents on the Surface Properties of an Esthetic Nano-Hybrid Composite. *Restor. Dent. Endod.* **2020**, *45*, e13. [CrossRef]
8. Araujo, F.S.; Barros, M.C.R.; Santana, M.L.C.; de Jesus Oliveira, L.S.; Silva, P.F.D.; Lima, G.D.S.; Faria-E-Silva, A.L. Effects of Adhesive Used as Modeling Liquid on the Stability of the Color and Opacity of Composites. *J. Esthet. Restor. Dent.* **2018**, *30*, 427–433. [CrossRef]
9. Münchow, E.A.; Sedrez-Porto, J.A.; Piva, E.; Pereira-Cenci, T.; Cenci, M.S. Use of Dental Adhesives as Modeler Liquid of Resin Composites. *Dent. Mater.* **2016**, *32*, 570–577. [CrossRef] [PubMed]
10. Barcellos, D.C.; Pucci, C.R.; Torres, C.R.G.; Goto, E.H.; Inocencio, A.C. Effects of Resinous Monomers Used in Restorative Dental Modeling on the Cohesive Strength of Composite Resin. *J. Adhes. Dent.* **2008**, *10*, 351–354.
11. Tuncer, S.; Demirci, M.; Tiryaki, M.; Ünlü, N.; Uysal, O. The Effect of a Modeling Resin and Thermocycling on the Surface Hardness, Roughness, and Color of Different Resin Composites. *J. Esthet. Restor. Dent.* **2013**, *25*, 404–419. [CrossRef] [PubMed]
12. De Paula, F.C.; Valentin, R.D.S.; Borges, B.C.D.; Medeiros, M.C.D.S.; De Oliveira, R.F.; Da Silva, A.O. Effect of Instrument Lubricants on the Surface Degree of Conversion and Crosslinking Density of Nanocomposites. *J. Esthet. Restor. Dent.* **2016**, *28*, 85–91. [CrossRef] [PubMed]
13. Paolone, G.; Formiga, S.; De Palma, F.; Abbruzzese, L.; Chirico, L.; Scolavino, S.; Goracci, C.; Cantatore, G.; Vichi, A. Color Stability of Resin-Based Composites: Staining Procedures with Liquids-A Narrative Review. *J. Esthet. Restor. Dent.* **2022**, *34*, 865–887. [CrossRef]
14. Zimmerli, B.; Koch, T.; Flury, S.; Lussi, A. The Influence of Toothbrushing and Coffee Staining on Different Composite Surface Coatings. *Clin. Oral. Investig.* **2012**, *16*, 469–479. [CrossRef]
15. Ertaş, E.; Güler, A.U.; Yücel, A.C.; Köprülü, H.; Güler, E. Color Stability of Resin Composites after Immersion in Different Drinks. *Dent. Mater. J.* **2006**, *25*, 371–376. [CrossRef]
16. Luo, M.R.; Cui, G.; Rigg, B. The Development of the CIE 2000 Colour-Difference Formula: CIEDE2000. *Color Res. Appl.* **2001**, *26*, 340–350. [CrossRef]
17. CIE. *CIE 015:2018 Colorimetry*, 4th ed.; International Commission on Illumination (CIE): Vienna, Austria, 2018.
18. Maske, T.T.; Hollanders, A.C.C.; Kuper, N.K.; Bronkhorst, E.M.; Cenci, M.S.; Huysmans, M.C.D.N.J.M. A Threshold Gap Size for in Situ Secondary Caries Lesion Development. *J. Dent.* **2019**, *80*, 36–40. [CrossRef] [PubMed]
19. Paolone, G.; Scolavino, S.; Gherlone, E.; Spagnuolo, G.; Cantatore, G. The "Pre-Finishing" Approach in Direct Anterior Restorations. A Case Series. *Dent. J.* **2021**, *9*, 79. [CrossRef] [PubMed]
20. Paolone, G.; Scolavino, S.; Gherlone, E.; Spagnuolo, G. Direct Esthetic Composite Restorations in Anterior Teeth: Managing Symmetry Strategies. *Symmetry* **2021**, *13*, 797. [CrossRef]
21. Pereira, P.-L.; Pereira, R.; Silva, B.-G.; Lins, R.-B.-E.; Lima, D.-A.-N.-L.; Aguiar, F.-H.-B. Effect of Wetting Agent Coverage on the Surface Properties of Resin Composite Submitted to Brushing and Staining Cycles. *J. Clini. Exp. Dent.* **2021**, *13*, 795–801. [CrossRef] [PubMed]
22. Lee, Y.-K.; Yu, B.; Zhao, G.-F.; Lim, J.I. Effects of Aging and HEMA Content on the Translucency, Fluorescence, and Opalescence Properties of Experimental HEMA-Added Glass Ionomers. *Dent. Mater. J.* **2010**, *29*, 9–14. [CrossRef] [PubMed]
23. Khokhar, Z.A.; Razzoog, M.E.; Yaman, P. Color Stability of Restorative Resins. *Quintessence Int.* **1991**, *22*, 733–737. [PubMed]
24. Ruyter, I.E.; Nilner, K.; Moller, B. Color Stability of Dental Composite Resin Materials for Crown and Bridge Veneers. *Dent. Mater.* **1987**, *3*, 246–251. [CrossRef]
25. *ISO 4049:2019*; Dentistry—Polymer-Based Restorative Materials. International Organization for Standardization: Geneva, Switzerland, 2019. Available online: https://www.iso.org/cms/render/live/en/sites/isoorg/contents/data/standard/06/75/67596.html (accessed on 1 July 2021).
26. Perez, M.D.M.; Ghinea, R.; Herrera, L.J.; Ionescu, A.M.; Pomares, H.; Pulgar, R.; Paravina, R.D. Dental Ceramics: A CIEDE2000 Acceptability Thresholds for Lightness, Chroma and Hue Differences. *J. Dent.* **2011**, *39*, e37–e44. [CrossRef] [PubMed]
27. Paolone, G. Direct composites in anteriors: A matter of substrate. *Int. J. Esthet. Dent.* **2017**, *12*, 468–481. [PubMed]
28. Bompolaki, D.; Lubisich, E.B.; Fugolin, A.P. Resin-Based Composites for Direct and Indirect Restorations: Clinical Applications, Recent Advances, and Future Trends. *Dent. Clin. N. Am.* **2022**, *66*, 517–536. [CrossRef] [PubMed]
29. German, M.J. Developments in resin-based composites. *Br. Dent. J.* **2022**, *232*, 638–643. [CrossRef]