DENTAL MATERIALS XXX (2018) XXX–XXX

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.intl.elsevierhealth.com/journals/dema

Does translucency influence cure efficiency and color stability of resin-based composites?

Vinícius Esteves Salgado[a,b], *Guilherme Ferreira Rego*[c], *Luis Felipe Schneider*[c,d,*], *Rafael Ratto de Moraes*[a], *Larissa Maria Cavalcante*[b,c,d]

[a] *Graduate Program in Dentistry, Federal University of Pelotas, Pelotas, RS, Brazil*
[b] *School of Dentistry, Salgado de Oliveira University, Niterói, RJ, Brazil*
[c] *School of Dentistry, Federal Fluminense University, Niterói, RJ, Brazil*
[d] *Nucleus for Dental Biomaterials Research, School of Dentistry, Veiga de Almeida University, Rio de Janeiro, RJ, Brazil*

ARTICLE INFO

Article history:
Received 21 June 2017
Received in revised form
2 February 2018
Accepted 23 March 2018
Available online xxx

Keywords:
Staining
Opacity
Hydrolysis

ABSTRACT

Objective. To determine if material's translucency influences the cure efficiency and color stability of resin-based composites (RBCs).

Methods. Four commercially-available RBCs indicated for aesthetic restorations were selected in different translucent/opaque shades: IPS Empress Direct (IED) A3 Dentin, A3 Enamel, Trans 20, and Trans 30; Filtek Z350 XT (FZX) A3D, A3B, A3E, and CT; Estelite $\sum$ Quick (EQ) OA3, A3, and CE; and Opallis (OP) DA3, EA3, and T-Neutral. Color was obtained in the L′C′h′ system at three distinct periods: 24 h after photoactivation (baseline), after 30 d of water storage (WS), and after 30 d of coffee storage (CS). The translucency parameter (TP) of each RBC was calculated at baseline. The degree of C=C conversion (DC) was obtained by Fourier-transform infrared spectroscopy at 0.05 mm (top) and 2 mm (bottom) surfaces; the cure efficiency considered the bottom/top ratio. The CIEDE2000 color difference (ΔE_{00}) was calculated considering the WS–baseline and CS–baseline values. Data were submitted to two-way ANOVA and Tukey's *post-hoc* test ($\alpha = 0.05$). Pearson's tests were used to analyze the correlations between TP and DC, and between TP and ΔE_{00}.

Results. For all RBCs, cure efficiency was not affected by materials' translucency. A positive, significant correlation was observed between TP and DC at the bottom surface for FZX only. For all RBCs, the higher the TP, the higher the ΔE_{00}. The ΔE_{00} was higher after CS than after WS, except for EQ A3. Positive correlation between TP and ΔE_{00} were observed for all materials.

Conclusion. The translucency did not influence the cure efficiency but affected the color stability for all RBCs.

Clinical significance. High-translucent RBCs presented lower color stability and should be used carefully.

* *Corresponding author at*: Nucleous for Dental Biomaterials Research, School of Dentistry, Veiga de Almeida University, Rio de Janeiro, Praça da Bandeira 149, CEP 20270150, Brazil.
E-mail addresses: schneider@uva.br, schneider@vm.uff.br, felipefop@gmail.com (L.F. Schneider).
https://doi.org/10.1016/j.dental.2018.03.019

Please cite this article in press as: Salgado VE, et al. Does translucency influence cure efficiency and color stability of resin-based composites? Dent Mater (2018), https://doi.org/10.1016/j.dental.2018.03.019

1. Introduction

One of the major causes for failure of resin-based composite restorations in anterior teeth is aesthetics [1]. The mismatch between the tooth structure and material may occur due to technical failure or the material's discoloration during its clinical lifetime. In direct restorations proper reproduction of all tooth characteristics needs to be considered depending on the clinical situation. Therefore, sometimes it is necessary to use several translucent/opaque shades of a restorative material to achieve the best match between the material and dental tissues from a single tooth. Translucency is one of the most important optical properties to consider when evaluating aesthetics. The translucency of resin-based composites results from the relationship between the refractive indices of the filler particles and resin matrix. The greater the difference, the lower the translucency [2]. It is known that the inorganic filler particles content and type [3–6], organic matrix type and fraction [4,7], may all affect the material's translucency.

Another component that might dictates the materials' aesthetics over time is the photoinitiator system used in the formulation [8–10]. The association of camphorquinone (CQ) with a tertiary amine remains the most common photoinitiator system in commercial composites. CQ has an intense yellow color, which gives the material a high potential for discoloration [9,10]. To overcome the aesthetic problems of this system, alternative photosensitizer molecules were tested, such as phosphine oxide derivatives. The diphenyl(2,4,6-trimethylbenzoyl)phosphine oxide, also known as TPO, is a component already present in some commercial composites [8,11,12]. TPO has demonstrated higher color stability [8,9] and higher curing efficiency than CQ [9,13], albeit having decreased depth of cure [14]. Another attempt to reduce the CQ content, based on a radical amplified photopolymerization (R.A.P. technology™), was recently proposed. Results available for materials formulated with this technology indicate increased degree of C=C conversion (DC), with no reported data regarding color stability [15].

In a previous study involving model composites, improved color stability was observed when alternative photoinitiators were associated with the CQ/amine system, particularly TPO [10]. However, in commercial resin-based composites, manufacturers usually do not disclose or specify the type and/or amount of the components for all available translucent/opaque shades. Even when the materials from the same brand are considered, other differences not restricted to the photoinitiator system are present, including filler loading, and presence of pigments or radical scavengers, for instance.

To achieve high-translucent shades, the manufacturers may decrease the amount of CQ/amine and/or use alternative photosensitizer molecules [11], or even decrease the inorganic content amount [4], which may compromise the cure efficiency and the color stability. Notwithstanding, the data in the literature regarding the influence of each resin-based composite's component over the physical properties derives from *in vitro* studies using experimental materials. Despite several studies had investigated the color stability or cure efficiency of commercial resin-based composites, none of them determined the influence of the translucency within each brand on these physical properties.

The aim of this study was to determine the cure efficiency and the color stability of four distinct commercial brands of restorative resin-based composite systems in their different available translucent/opaque shades. The research hypotheses of this study were that for all resin-based composite brands:

i) high-translucent materials would present lower cure efficiency;
ii) high-translucent materials would present lower color stability.

2. Materials and methods

2.1. Study design

This *in vitro* study involved distinct factorial designs to evaluate the effect of the translucency over the cure efficiency and color stability of four commercial resin-based composite brands. For each analysis, the sample size was the same of previous studies [9,10]. Translucency was quantitatively assessed by the translucency parameter (TP) formula. For the cure efficiency (n = 6), two factors were evaluated: 'translucency' (three or four levels, depending on the commercial brand) and 'surface' (top or bottom). For color measurements (n = 6), two factors were evaluated: 'translucency' (three or four levels, depending of commercial brand) and 'ageing condition' (baseline, after water storage, and after coffee solution storage). The response-variables tested were cure efficiency, determined by the top/bottom DC ratio, individual L′C′h′ color parameters, and CIEDE2000 color difference.

2.2. Materials tested

Four distinct commercially-available resin-based composites indicated for aesthetic restorations were tested [16–20] (Table 1) in their different available translucent/opaque shades: the microhybrid (stated as "nanohybrid" by manufacturer) IPS Empress Direct (Ivoclar Vivadent, Schann, Liechtenstein), the nanofilled Filtek Z350 XT (3M ESPE, St Paul, MN, USA), the submicron Estelite $\sum$ Quick (Tokuyama Dental, Tokyo, Japan), and the microhybrid Opallis (FGM, Joinville, SC, Brazil). The materials were classified according to their inorganic content [21]. For this study, the translucency variations within A3 shade were selected due the VITA A3 shade represents one of the most common human teeth color [22], besides the more translucent/opaque varieties in this shade.

2.3. Optical data and translucency parameter

Six disc-shaped specimens were made for each group using a cylindrical metal mold of 8-mm inner diameter and 2-mm thickness. After the composite insertion, the top surface was covered with a Mylar strip and made flat by pressing down with a glass slab. The specimens were light-activated for 30 s from the top surface using a large spectrum (385–515 nm) light-emitting diode curing unit (Bluephase G2, Ivoclar Vivadent)

Please cite this article in press as: Salgado VE, et al. Does translucency influence cure efficiency and color stability of resin-based composites? Dent Mater (2018), https://doi.org/10.1016/j.dental.2018.03.019