DENTAL MATERIALS XXX (2018) XXX–XXX

Available online at www.sciencedirect.com

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Optical properties of composite restorations influenced by dissimilar dentin restoratives

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ARTICLE INFO

Article history:
Received 26 October 2017
Received in revised form
16 January 2018
Accepted 16 January 2018
Available online xxx

Keywords:
Color
Translucency
Biodentine
EverX
Hydroxyapatite
Layered composite restoration
Layering technique
Dentin restorative
Enamel layer
Composite

ABSTRACT

Objectives. To evaluate optical properties (color and translucency) of 'sandwich' restorations of resin-based composites and esthetically unfavorable dentin restoratives.
Methods. Cylindrical 'dentin' specimens (8 mm in diameter and 2 mm thick, N = 5/group) were prepared using EverX Posterior (GC), Biodentine (Septodont), experimental hydroxyapatite (HAP) or conventional composites (Gradia Direct Posterior, GC; Filtek Z250 and Filtek Z500, 3M ESPE). Capping 'enamel' layers were prepared using composites (Gradia Direct Posterior, Filtek Z250 or Z550) of A1 or A3 shade and the following thickness: 0.6, 1 or 2 mm. Color (ΔE) and translucency parameter (TP) were determined using a spectrophotometer (VITA Easyshade Advance 4.0, VITA Zahnfabrik). Data were statistically analyzed using analysis of variance with Tukey's post-hoc tests ($\alpha = 0.05$).
Results. TP was greatly affected by layer thickness, whilst ΔE depended on shade and layer thickness of the capping composite. HAP and Biodentine showed significantly lower TP and higher ΔE (deviation from 'ideal white') than composites ($p < 0.05$). Greater TP was seen in EverX_composite groups than in corresponding control groups of the same shade and thickness. TP of composites combined with Biodentine or HAP was below 2, lower than the corresponding control groups ($p < 0.05$). Within-group differences of ΔE were greatest in HAP_composite groups. EverX_Gradia and EverX_FiltekZ250 combinations showed the most comparable ΔE with the control groups.
Significance. A 2 mm thick layer of composite covering dentin restoratives with unfavorable esthetics is recommended for a final 'sandwich' restoration that is esthetically comparable to a conventional, mono-composite control restoration.

1. Introduction

High esthetic requirements present a challenge in restorative dentistry due to the complex structure of dental tissues. This complexity is reflected in the specific micro-morphology, variable thickness, anisotropic and polychromatic nature as well as different composition of enamel and dentin [1,2]. The characteristic layout of enamel prisms and dentinal tubules and different amounts of organic substance cause differences in the optical parameters of these two tissues. Optical properties of contemporary composite restorations and natural

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https://doi.org/10.1016/j.dental.2018.01.017

Table 1 – Materials used in the study.

Material (code)	Manufacturer	Type	Composition[a]
Filtek Z550 (Z550)	3M ESPE, St. Paul, MN, USA	Nano-hybrid	Matrix: BisGMA, UDMA, BisEMA, PEGDMA, TEGMA Filler type: surface-modified zirconia/silica with a median particle size of 3 μm or less; Non-agglomerated/non-aggregated 20 nm surface-modified silica particles Filler content: 82 wt%
Filtek Z250 (Z250)	3M ESPE, St. Paul, MN, USA	Micro-hybrid	Matrix: BisGMA, BisEMA, UDMA, TEGDMA Filler type: zirconia, silica Particle size 0.6 μm Filler content: 82 wt%
Gradia Direct Posterior (Gradia)	GC Corporation, Tokyo, Japan	Micro-hybrid	Matrix: UDMA co-monomer matrix Filler type: silica, prepolymerized fillers, fluoroalumino-silicate glass Particle size 0.85 μm Filler content: 80 wt%
Biodentine (Biodentine)	Septodont, Saint-Maur-des-Fossés, France	Tricalcium-silicate cement	Powder: tricalcium silicate, dicalcium silicate, calcium carbonate, zirconium oxide, iron oxide Liquid: calcium chloride, hydrosoluble polymer, water
Hydroxyapatite inserts (HAP)	Proprietary material	HAP based bioceramic	Hydroxyapatite as the dominant phase and low amount of α- and β-tricalcium phosphate phase
EverX Posterior (EverX)	GC Corporation, Tokyo, Japan	Fiber reinforced bulk-fill composite	Matrix: BisGMA, PMMA, TEGDMA Filler type: Short E-glass fiber filler, barium glass

[a] Manufacturer's data.

teeth, despite differences in chemical composition and microstructure, contribute to excellent esthetic results [1–4].

A commonly accepted approach to material placement in clinical practice is a 'layered color matching' technique aimed at matching similar optical characteristics of the filling material and dental tissues in both anterior and posterior region [5,6]. Though color matching is more important in the anterior region, high esthetic demands require that the same approach is applied in the posterior region as well, warranting research data for such clinical situations, irrespective of the fact that they may be less frequent in daily practice.

For restoring Class I and II cavities, the layering technique of composite placement is used as a widely accepted 'gold standard' [7,8]. This technique ensures complete polymerization of composite materials, reduces polymerization shrinkage stress [9] but also allows matching optical properties of composite materials and dental tissues [1,4,7]. The color of the final restoration is not only influenced by the final composite layer [2–4], but is a result of optical properties of all layers combined [10].

The choice of shades is not always easy, considering that color of the composite changes after polymerization [11–14]. This change is affected by the initiator system [14,15] as well as the change in the refractive indices of the polymer relative to the fillers [16,17]. Furthermore, a number of factors may cause long-term color change, such as dehydration, chemical degradation, leakage, poor bonding and increased, surface roughness [18].

The 'layered color matching' technique is not suitable for the latest group of dental composites — sculptable 'bulk-fill' composites. Applied in 4–5 mm thick layers with a reduced number of available shades, these materials are intended for use as single-shaded materials, often for restoring the entire cavity in a single layer. An exception is fiber-reinforced EverX Posterior (GC) which requires a capping layer of a universal composite because glass fibers prevent polishability and hinder optimal esthetic results.

Another potentially compromising situation for highly esthetic composite restorations is dentin reconstruction in large cavities using non-esthetic restoratives, such as tricalcium silicate cements (*e.g.* Biodentine, Septodont) or hydroxyapatite (HAP) inserts [19]. There is very little information in the literature about esthetic properties of Biodentine when used as dentin restorative and its effect on the final restoration color [20,21]. Teeth restored with a 'sandwich' restoration of Biodentine and composite showed comparable color stability to composite restoration *in vitro* [21]. Conversely, perceptive coronal discoloration was found in a bovine tooth model following endodontic treatment [20]. Biodentine may be used to restore dentin in permanent restorations requiring a capping layer of resin-based composite.

Experimental HAP inserts have shown satisfactory bonding to dental composites and the ability to reduce polymerization shrinkage of insert-containing restorations [19]. Esthetic properties of restorations containing HAP inserts have not been tested before. The clinicians may face dilemmas related to the

Please cite this article in press as: Marjanovic J, et al. Optical properties of composite restorations influenced by dissimilar dentin restoratives. Dent Mater (2018), https://doi.org/10.1016/j.dental.2018.01.017