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The effect of various dentifrices on surface roughness and gloss of resin composites

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ABSTRACT

Objectives: The purpose of this study was to evaluate the effect of different levels of abrasiveness (RDA) of dentifrices on the gloss and surface roughness of resin composites after toothbrushing.

Methods: Sixty disk-shaped composite specimens ($D = 10.0$ mm, 2-mm thick, $n = 15$ per material) were made of: microfill (Durafill), nanofill (Filtek Supreme), minifill hybrid (Filtek 250), and nanohybrid (Premise). One side of each specimen was finished with a carbide bur and polished with Enhance and Pogo. Five specimens of each composite were randomly assigned to one of the dentifrices, Colgate Total (CT; RDA 70), Colgate baking soda & peroxide whitening (CBS; RDA 145), and Colgate tartar control & whitening (CTW; RDA 200). Surface gloss was measured with a glossmeter and surface roughness with a profilometer before and after toothbrushing with a 1:2 slurry (dentifrice/deionised water) at 5760 strokes in a brushing machine (~1 Hz). Results were analyzed by three-way ANOVA/Tukey's ($p < 0.05$).

Results: There was a significant reduction in gloss and increase in surface roughness after brushing with all dentifrices. There was no significant difference in gloss when Durafill was brushed with any dentifrice; the other composites showed less gloss reduction when brushed with CT. Durafill, Supreme and Premise did not show significantly different surface roughness results and CBS and CTW did not produce significantly different results.

Conclusions: Dentifrices of lower abrasivity promote less reduction in gloss and surface roughness for composites of different particle sizes after brushing. Composites containing smaller average fillers showed less reduction in gloss and less increase in surface roughness than ones with larger fillers.

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1. Introduction

Over the past two decades, dentistry has witnessed substantial progress in the development and application of resin-based composites. Over the years, several changes have been made in the fabrication of dental resin composites to obtain restorations with better color stability over time,[1] greater wear resistance[2] and clinically acceptable surface smoothness.[3] To achieve the last goal, manufacturers predominantly have reduced the diameter of the filler particles to produce composites with a good mix of polishability and strength.

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Table 1 – Resin composites evaluated in the study.

Resin composite	Type	Inorganic filler level	Average particle size	Manufacturer	Lot number
Durafill VS	Microfill	52 wt%	40 nm	Heraeus Kulzer Gruner, Hanau, Germany	010201
Filtek Supreme Plus	Nanofill	78.5 wt%	20 or 70 nm	3M ESPE Dental Products St. Paul, MN, USA	20061004
Filtek Z250	Minifill hybrid	82 wt%	0.6–0.8 μm	3M ESPE Dental Products St. Paul, MN, USA	20090713
Premise	Nanohybrid	84 wt%	0.4 μm and 20 nm	Kerr Orange, CA, USA	3204945

Table 2 – Dentifrices evaluated in the study.

Dentifrice	RDA value	Manufacturer	Lot number
Colgate Total (CT)	70	Colgate-Palmolive Company New York, NY, USA	8268MX1139
Colgate baking soda & peroxide whitening (CBS)	145	Colgate-Palmolive Company New York, NY, USA	9116MX1113
Colgate tartar control/whitening (CTW)	200	Colgate-Palmolive Company New York, NY, USA	9193US56D

The smooth surface of a restoration provides both optimum esthetics and low plaque accumulation.[4] A rougher surface texture can lead to decreased gloss and increased discoloration of the material surface, both of which affect the esthetic quality of a restoration.[5] Surface roughness refers to the finer irregularities of the surface texture that usually result from the production process or the material's characteristics.[6] A clinical study revealed that a mean roughness of 0.2 μm is the critical threshold value for bacterial retention.[7] Another study reported that a change of surface roughness in the order of 0.3 μm can be detected by the tip of the patient's tongue (Jones et al., 2004).[8]

The effects of finishing and polishing procedures on surface roughness and gloss of resin composites have been extensively evaluated.[9–11,3,12–32] Studies have shown that the surface roughness and gloss are dependent on the composite and polishing system investigated. The effect of toothbrushing on surface roughness[33–40] and gloss[41] of composites has been investigated as well. It is clinically significant to determine the performance of the restoratives as a consequence of toothbrush abrasion because this phenomena increases the surface roughness and decreases the gloss, thus affecting the esthetic quality of a restoration. Although several studies have evaluated the effect of brushing on dental composites, the effect of the abrasiveness of dentifrices on the surface roughness and gloss of resin composites is largely unknown. To date, one study evaluated the abrasiveness of seven dentifrices on a microfill composite and showed that a whitening dentifrice was significantly less abrasive to the microfill composite compared to the other dentifrices tested.[42]

To achieve cleaning, the abrasive systems in dentifrices have to provide a certain degree of abrasiveness with respect to the surface of the teeth. It is important, however, that abrasion of enamel and dentin be of an acceptably low level to prevent the surface of the teeth from being damaged by the daily use of the dentifrice. Abrasivity measurements are obtained by radioactive dentin abrasion or radioactive relative abrasion (RDA).[43] Different formulas of dentifrices present different RDA values. The RDA values may vary from 30 to 200–250 being the American Dental Association recommended limit (Consumer Reports reviewed toothpastes, 1998).

The purpose of this study was to evaluate the effect of three different levels of abrasiveness of dentifrices on the surface roughness and gloss of four direct resin composites after simulated toothbrushing.

The null hypotheses were: (1) there would be no difference in surface roughness and gloss among the investigated resin composites before and after simulated toothbrushing and (2) there would be no difference in surface roughness and gloss produced by the investigated dentifrices after simulated toothbrushing.

2. Methods and materials

Four commercial resin composites (Table 1) and three dentifrices (Table 2) were evaluated in this study. The four resin composites were chosen because of the difference in their particle sizes, and the three dentifrices were selected because they possess low, moderate, and high RDA values (Table 2). Sixty disk-shaped specimens (D = 10.0 mm, 2-mm thick, n = 15 per composite and n = 5 per dentifrice) were made by packing uncured composite (A2 enamel shade) into a metal ring mold. Mylar strips were placed over each surface of the uncured composite to prohibit oxygen inhibition. A 500 g load was placed on the mold for 20 s to extrude the excess material. The specimens were then light-polymerized for 40 s using the Demi light-curing unit (Kerr, Danbury, CT, USA) with an 11 mm diameter light tip. The energy of the polymerisation light was monitored with a dental radiometer (Model 100, Kerr Demetron, Danbury, CT, USA) after initially being measured with a laboratory grade laser power meter (Power Max 5200, Molectron, Portland, Oregon), and averaged ~600 mW/cm^2.

Immediately after the light-curing cycle the specimens were taken from the mold and initially finished with a 16-fluted carbide finishing bur (H135.31.014 #ET9- Brassler USA, Savannah, GA) with light pressure removing the initial shiny surface resulting from curing against the Mylar strip, and to simulate a clinical finishing procedure. This procedure was done in an uniform manner using a device with a sliding stage that is moved into a stabilized bur. The specimens were positioned on a 1 mm thick metal ring and attached to the base with double-sided adhesive tape in such a way that the specimen was placed 1 mm above the base of the ring to facilitating the finishing procedure. One trained operator performed the finishing. Five specimens of each resin composite were then randomly assigned to receive the final