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Effect of cigarette smoke on color stability and surface roughness of dental composites

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ABSTRACT

Objective: To evaluate the color stability and surface roughness of 3 dental composites subjected to cigarette smoke and brushing.

Methods: Twenty specimens were prepared for each type of restorative material used: nanohybrid (Tetric N-Ceram); hybrid (Z250-3M ESPE) and silorane-based microhybrid (Filtek P90-3M ESPE), which were divided into 2 groups ($n = 10$), according to the type of finishing/polishing received: Group 1 – papers with decreasing abrasive grit and Group 2 – polyester matrix (without polishing). After initial readouts of color (Easy Shade-VITA) and surface roughness (SJ-201P Mitutoyo), specimens were subjected to action of smoke from 20 cigarettes, (Marlboro Red–Philip Morris). After each cigarette, the samples were submitted to brushing in a standardised device. After this, final readouts were taken to calculate change in color (ΔE and ΔL) and roughness (ΔRa), which were statistically analysed (2-way ANOVA, Bonferroni, and Student's-t tests respectively, $p < 0.05$).

Results: Tetric N-Ceram presented color change at clinically unacceptable levels ($\Delta E > 3.3$) when the polyester strip was used for finishing, a result differing ($p < 0.05$) from those of the other composites, which presented no difference between them ($p > 0.05$). Unpolished composites presented higher Ra values than those that were polished ($p < 0.05$), with exception of the silorane based composite.

Conclusion: Absence of polishing increases cigarette capacity to stain composites and surface roughness of composites, with exception of the silorane based type.

1. Introduction

According to the World Health Organization, there are approximately 1 billion smokers all over the world[1] which is reason for great concern, since tobacco use is among the main avoidable causes of infirmity and death.[2]

Today, society places great value on the body and aesthetics. This gradual appreciation has led to a large number of patients, whether they are smokers or not, to seek not only a perfect body but a perfect smile as well. Resin composite is the material of choice for direct restorations when aesthetics is important. However, in spite of the great advancement of composites and improvement in both mechanical and aesthetic properties, some deficiencies remain, mainly color instability.[3]

Color change generally occurs for three reasons: (1) external discolorations due to plaque accumulation and stains; (2) surface or sub-surface alterations promoting surface degradation and favouring the penetration and reaction of coloring agents with the resin composite surface (adsorption); and (3) intrinsic discolorations due to physical-chemical

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reactions in the deep portions of the restorative material.[4] Surface staining is commonly caused by the penetration of coloring agents in foods and beverages such as coffee,[5–10] tea,[5,11] red wine[6,8,10,11] and cola based soft drinks.[8,11] Nevertheless, there are few studies in the literature about the effect of cigarette smoke on aesthetic restorative materials.[7,12–16]

The first studies were conducted by Raptis et al.,[12] who found significant change in the color stability of composites continually submitted to the smoke from 40 cigarettes. Recent studies[15,16] have evaluated the effect of cigarette smoke associated with alcoholic beverages and have demonstrated that the association of these two agents could potentiate the staining of restorative materials.

As regards surface roughness, it is known that this is influenced by the size, distribution and volume of load particles, and the type of finishing and polishing procedures used, which may retard staining[17,18]. Sarac et al.[19] have suggested that the smaller the particle size, the better would be the polishing, and consequently, there would be less color change.

In the case of smoker patients, restorations are exposed to cigarette smoke, which is composed of thousands of toxic substances such as carbon monoxide, ammonia, nickel, arsenic, tar and heavy metals such as lead and cadmium.[20] When this smoke comes into contact with the tooth and restoration surfaces aesthetics is compromised to a large extent, as the teeth of smoker individuals become yellowed or even blackened due to impregnation by contaminants from cigarette smoke.[21,22]

Since aesthetics is a concern that affects the population in general nowadays, and since color change is one of the main reasons for replacing composite restorations,[23] the aim of this study was to evaluate the *in vitro* change in color and roughness of the surfaces of composite with different particle sizes, submitted to cigarette smoke. The hypotheses tested were that exposure to cigarette smoke is capable of producing color change and increase in surface roughness of composites, irrespective of the type of finishing used.

2. Material and methods

The composites evaluated are shown in Table 1. Twenty test specimens were fabricated from each type of composite, using a Teflon matrix (8 mm in diameter × 2 mm thick) in two increments. A polyester matrix was placed on the last increment, and on top of this, a glass slide, with the purpose of providing superficial smoothness and flow of excess material. After this, the test specimens were light activated (FLASHlite 1401, Discus Dental, Culver City, CA, USA – ≥1100 mW/cm^2, light wavelength in the band between 460 and 480 nm), for 40 s, in accordance with the manufacturers' recommendations.

After the matrix was removed, the test specimens were separated into two groups ($n = 10$), according to the type of finishing/polishing performed: Group 1 – abrasive water papers (600, 800 e 1200 – Norton Abrasivos, Guarulhos, SP, Brazil); and Group 2 – without polishing, only the use of the polyester matrix at the time of obtaining the samples. After fabrication, the samples were stored in distilled water at 37° for 24 h.

Initial color readouts (Spectrophotometer Easyshade, VITA Zahnfabrik, BadSäckingen, Germany) and surface roughness (Surface roughness meter Model SJ-201P Mitutoyo, Tokyo, Japan) readouts of the test specimens were taken. For color readouts, the test specimens were dried with absorbent paper, and placed on a standard white background. The observation pattern simulated for color readout followed the CIE L*a*b* system (Comission Internationale de I'Éclairage). This consists of two axes, a* and b*, that have right angles and represent the dimension of tonality or color. The third axis is luminosity L*. This is perpendicular to the plane a* b*.

The surface roughness readout was made over a distance of 5 mm with a cut-off of 0.8 mm, at a speed of 0.25 mm/s. Three readouts were taken at different sites on the sample surface. The mean of the values was considered the mean roughness (Ra) of the samples.

After this, the test specimens were submitted to the action of cigarette smoke. Therefore, a device was developed (Fig. 1) using a sectioned test tube, with a support at one end to fit in the cigarette, and on the other end, a cap fitted with a system that caused a negative pressure to aspirate the smoke released by the cigarette, thereby leading to impregnation of the restorative materials with the substances contained in the smoke, for the purpose of reproducing *in vitro* the conditions of a smoker's oral cavity. The test specimens were put into a chamber using a supporting device that would allow the samples to remain in a vertical position, so that the greater part of their surface would be exposed to the cigarette smoke. For each sample, 20 cigarettes (Marlboro Red, Phillip Morris) were used and each cigarette was burned in a standard time of 10 min.

After exposure to each cigarette, the test specimens were brushed, using a standardised device (Fig. 2) with the intention

Table 1 – Dental composites used in the study.

Material A2		Composition
Filtek Z 250	Hybrid composite	Bis-GMA, TEGDMA, UDMA, BisEMA, 60% of filler: zirconium/silica particles (0.01 μm–3.50 μm, mean size 0.6 μm,).
Tetric N-Ceram	Nanohybrid Composite	Bis-GMA, UDMA, TEGDMA, BIS-EMA, 55–57% of filler: Barium glass, ytterbium trifluoride, mixed oxides and silica dioxide particles (0.04–3.0 nm, mean size 0.7 nm)
Filtek P90	Micro hybrid Composite	Hydrofobic silorane based matrix, 55% of fillers: quartz and yttrium fluoride particles (mean size 0.47 μm)

Bis-GMA, bisphenol A-glycidyl dimethacrylate; Bis-EMA, bisphenol A-polyethylene glycol diether dimethacrylate; UDMA, urethane dimethacrylate; TEGDMA, triethylene glycol dimethacrylate.