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Influence of fluoride-containing solutions on the translucency of flowable composite resins

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The aim of this study was to evaluate the influence of fluoride-containing solutions on the translucency of flowable composite resins, with respect the immersion time. Flow-It! (FI) and Natural Flow (NF) composite resins and three commercial brands of fluoride-containing solutions (Fluordent, Fluorgard and Oral B) were used. Specimens were prepared and stored in the solutions at 37°C, until the measurements were made after the following treatments: T1 - after 1 hour in relative humidity; T2 - after 1 h in solution; T3 - 24 h; T4 - 48 h; T5 - after a week; from T9, the measurements were accomplished weekly, up to 30-day immersion. To obtain translucency values an electrophoresis equipment was employed. Data were submitted to ANOVA and Tukey tests. The results disclosed that NF showed highest values of translucency and was statistically different from FI ($p < 0.001$). As regards the solutions, Fluordent and Oral B presented similar values and were statistically superior to Fluorgard ($p < 0.05$). Concerning the immersion time, similar results were observed for the different evaluation periods. It may be concluded that the fluoride-containing solutions affected the translucency of the composite resins, independently of the materials used. Among the tested resins, NF presented the best performance.

1. Introduction

Over last decades, dental research has notably improved restorative techniques and great effort has been directed to develop materials with optimal physical, mechanical, chemical and biological properties [1, 2], aiming to reproduce, as reliably as possible, the characteristics and appearance of lost dental tissue. Since personal appearance has become a major concern and a social demand, there has been an increasingly outstanding interest for aesthetic restorative treatments in dental practice. Therefore, to date, it is mandatory for the clinicians to be aware of the different aspects and variables involved in the global concept of aesthetics as well as to have knowledge of color and its three-dimensional nature.

Several features are claimed to contribute to the alteration of the optical and aesthetic properties of restorative materials. Clinically, it is observed that aesthetic materials are highly vulnerable to color alteration, caused mainly by poor oral hygiene, ultraviolet rays and staining produced by some types of food and beverages [3].

The aesthetics of a restorative material consists not only in color match, but also requires that its translucency and texture be similar to dental structure. One measure of color as a value, what may be defined as glaze or brightness of material, is related to translucency [4]. Since the restorative materials are supposed to replace tissues with different translucency, i.e., enamel and dentin, the achievement of an ideal translucency becomes a complex procedure and sometimes a problem to the professional [5]. Even so, while fabricating an aesthetic restoration, all efforts should be made to keep its color as close as possible to natural.

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Many factors may influence the alteration of aesthetic materials translucency because they are constantly subjected to an aggressive oral environment, such as many kinds of food and beverages with natural and artificial colorings, certain components of cigarette smoke (tar and nicotine) or even the accrual of bacterial bio-film. Due to these factors, staining of restorations may occur and superficial alteration occurs in a short period of time [6].

The influence of liquids absorption by the material—and the consequent stain retention [7, 8]—must also be considered. Such condition becomes a matter of major concern when affects some important properties, mainly in color stability and in staining strength [9].

The use of fluoride-containing solutions as daily mouthrinses is quite widespread among dental patients. However, it has been reported that the routine use of such products interferes with the properties of aesthetic restorative materials, such as glass-ionomer cements, compomers and composite resins [10–12].

Further studies are definitely required to evaluate commercial brands of fluoride-containing solutions, with the purpose of assessing how they affect the aesthetic and optical properties of restorative materials. This would allow an improved and safer association of re-mineralization and aesthetics characteristics, thus increasing the longevity of restorations.

The reported research aimed to assess the influence of fluoride-containing solutions on the translucency of flowable composite resins, as regards the material used for the restoration, fluoride-containing solution and immersion time.

2. Material and methods

Two flowable composite resins - Flow-It! [Jeneric/Pentron (M1) and Natural Flow - DFL (M2)] and three solutions of 0.05% sodium fluoride [Fluordent Reach (Johnson and Johnson - green - S1), Fluorgard (Colgate - red - S2) and Oral B (Gillette - blue - S3)] were used (Table I). Thirty specimens (10 mm ϕ and 2 mm thick) were prepared for study, with five for each tested condition of either the material or solution [13].

The specimens were fabricated using as matrixes stainless steel rings on a glass plate, covered by colorless cellophane. The composite resin was inserted in a single increment. After insertion of the resin, the rings were covered by another glass plate also covered with colorless cellophane and a 1 kg weight was positioned on it for 15 s to allow a uniform flow of the resin, followed by ligth-curing (XL3000, 3M Dental Products, St Paul, MN 55144 - 500 mW/cm^2 energy output) and release from the rings. Afterwards, the specimens were immersed in cold water to keep them in 100% relative humidity for one hour.

The values of translucence were obtained using electrophoresis equipment JOUAN (Jouan - Paris - series 021 A/No. 10), which measured the light radiation crossing the specimen. The light source excites the photoelectric cell, which in turn emits a signal to the galvanometer according to the degree of excitation from the light source, on a 0 to 100 scale, thereby indicating percentage of light that activated the photoelectric cell. This is the percent value of translucence.

Translucence was measured at nine after nine treatments, namely: T1 the measurement performed after 1 h in relative humidity, T2 after 1 h of immersion in fluoride-containing solution, T3 after 24 h of immersion, T4 after 48 h, T5 after a week and from T6 on, the measurements were accomplished weekly, up to the completion of 30-day immersion (T9).

Before each reading, the specimens were rinsed in distilled water for 1 min and dried with absorbing paper. Between the readings, they were immersed in fluoride-containing solutions at 37°C ± 1°C.

Data obtained were analyzed as regards their distribution. As data displayed a normal distribution, they were submitted to three-way ANOVA (material, time and solution) in order to distinguish the averages of the different experimental groups and Tukey test ($p < 0.05$) was employed to study their interaction.

3. Results

An overview of the results reveals that Natural Flow (41.96%) showed the highest values of translucency and was statistically different ($p < 0.01$) from Flow-It! (30.27%).

As regards the solutions, it was noticed that Fluorgard was the solution that most altered the translucency

TABLE I Specifications of materials tested

Material	Composition	Manufacturer	Lot
Fluordent reach	Sorbitol, ethyl alcohol, glycerin, Pluronic F-127, monobasic Na phosphate and dibasic sodium phosphate, mint flavor, demineralized water.	Johnson & Johnson Ind. e Com. Ltda, São José dos, Campos, SP, 12237-350	nf
Fluorgard	Sorbitol, water, sodium biphosphate, phosphoric acid, sodium fluoride, red stain.	Colgate - Palmolive, Osasco, SP, 06020-170	LG#1
Oral B	226 ppm fluoride (Na fluoride 0.05%), demineralized water, glycerin 96%, monohydrated cetylpyridinium chloride, mint flavor, sodium saccharin, sodium benzoate.	Gillette do Brasil Ltda, Rio de Janeiro, RJ, 20062-970	W - 086 - 2
Flow-It!	Ethoxylated Bis-GMA, TEGDMA, barium glass, silica, TiO_2, photo initiator, accelerator, UV stabilizer, inorganic pigments, 70,5% poids, Load size: 1.5 μ	Jeneric Pentron Incorporated Wallingford, CT 06492 - USA	14822
Natural flow	Boro-aluminum silicate glass, 43% poids, Load size: nf	DFL Ind. e Com. Ltda, Rio de Janeiro, RJ, 22713-001	98121070

nf—not furnished by manufacturer.

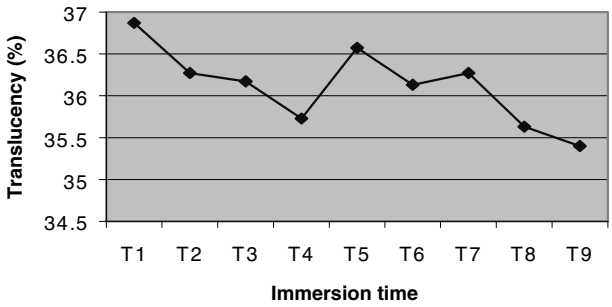

Figure 1 Mean translucency (%) to immersion time.

of the tested resins (34.02%), showing statistically significant difference ($p < 0.05$) among them, decreasing the values of translucency. Fluordent Reach and Oral B solutions influenced the materials' translucency to a lower degree and their values showed statistical similarity between them (37.03% and 37.29%, respectively).

As regards the immersion time, the use of these solutions provided a significant and gradual alteration ($p < 0.05$) of translucency of the tested materials (Fig. 1) and initially showed high values.

The interaction among materials, solutions and immersion time can be observed on Table II.

From the analysis of Table II, it may be assumed, for material M, that there was a decline of translucency when immersed in every solution tested, with values exhibiting higher variation. However, for material M2, these values exhibited higher variation either for M2S1 as for M2S3, resulting in an increase of translucency of the tested resin along the course of the analyzed immersion times.

4. Discussion

In the present study, it was observed that the tested fluoride-contain solutions altered the translucency of the studied materials. The association of aesthetic restorative materials to products with anti-cariogenic activity, such as fluoride-containing solutions with dyes, mainly those for daily use, demands more attention because these substances can interfere with the aesthetic properties of restorative materials, including their translucency.

The alterations, which occur, are influenced by several factors, such as solution's composition, pH and inclusion of dyes. The review of current literature shows few reported researches that corroborate the influence of dyes on translucency of flowable composite resins. Nevertheless, studies involving other aesthetic restorative materials, like silicate cement, glass-ionomer cement and conventional composite resins [8, 9, 14, 15] proved reveled a decrease in the translucency, caused by the consumption of food with natural or artificial dyes or even mouthrinse solutions.

Dye retention may be a consequence of water or liquid absorption by a restorative material. This might not only interfere with color stability, but also cause debasing of the resin/load union, resulting in decrease of material's translucency, carrying stained products into resin matrix, leading to the appearance of stains, which are quite difficult to be removed [14, 15]. In the present study, all the materials had the translucency altered by the studied solutions. However, it was noticed that the one with red dye did it more intensively. A feasible explanation for this behavior would be the fact that the concentration of this dye is apparently higher than that of the blue and green ones. Nonetheless, it may not be affirmed because the manufacturer did not provide such information.

Flowable composite resins have a composition with lower load particles than micro-hybrid and microparticle resins. Thus, there is a higher proportion of matrix resin, which can benefit dye retention. In a study that evaluated the translucency of flowable composite resins immersed in the same solutions as those used in the present study, Friedrich *et al.* [10] observed that Fluordent Reach has determined superior values of translucency as compared to the results found in the present study.

It was noticed in this study that Oral B solution showed lower influence on translucency of tested resins, which supports the findings of Friedrich *et al.* [10]. According to Catirse *et al*. [11, 16], the same results have also been found when other aesthetic materials, such as glass-ionomer cement and polyacid-modified composite resins were analyzed, following the same methodology.

It has been shown that the pigmentation affects the translucency of a material in such a way that the higher the pigmentation the more opaque the material [17–19]. Therefore the clinician should be careful with the prescription of home-care mouthrinse solutions containing dye, to avoid that these solutions interfere with the longevity of aesthetic restorations.

Besides staining and composition, other factors may also have influence on the staining or on the decrease

TABLE II Mean (%) and standard-deviation of different groups tested

	M1S1 (DP)	M1S2 (DP)	M1S3 (DP)	M2S1 (DP)	M2S2 (DP)	M2S3 (DP)
T1	32.2 (±2.5)a	30.4 (±1.94)a	33.6 (±1.67)a	41.8 (±1.78)f	40.2 (±1.09)b	43.0 (±1.00)d
T2	30.0 (±2.23)b	28.8 (±1.30)b	31.2 (±2.16)cd	42.8 (±1.92)cd	41.8 (±2.16)a	43.0 (±1.73)d
T3	30.6 (±2.40)b	27.0 (±1.22)d	29.6 (±2.07)g	43.2 (±2.38)bc	41.6 (±1.81)a	45.0 (±1.41)a
T4	30.0 (±2.12)b	27.8 (±1.30)c	30.8 (±1.64)de	42.6 (±2.70)cde	40.2 (±2.16)b	43.0 (±1.22)d
T5	31.0 (±3.31)b	29.2 (±3.03)b	29.8 (±1.30)g	44.0 (±2.34)a	41.4 (±2.30)a	44.0 (±2.54)b
T6	32.2 (±2.86)a	29.0 (±1.87)b	31.8 (±1.78)bc	42.0 (±2.00)ef	38.0 (±2.00)c	43.8 (±1.30)bc
T7	32.4 (±2.60)a	29.0 (±1.87)b	32.4 (±1.51)b	43.0 (±2.54)bcd	37.6 (±2.30)c	43.2 (±0.83)cd
T8	32.0 (±2.34)a	28.0 (±1.22)c	30.6 (±1.94)def	42.8 (±2.28)cd	37.4 (±2.40)c	43.0 (±0.70)d
T9	30.4 (±2.30)b	27.2 (±1.64)d	30.2 (±1.30)efg	43.6 (±3.04)ab	37.8 (±3.56)c	43.2 (±2.58)cd

Same letters correspond to statistical similarity.

of materials' translucency. The presence of some substances in the fluoride solutions, used for immersion of specimens in this study, may also alter translucency of aesthetic materials, which became more opaque. Cetylpyridinium chloride, included in Oral B solution, in spite of its improved clinic performance as an oral antiseptic, shows undesirable side effects, such as staining of tongue, transitory gum irritation and light pigmentation of teeth [20]. There are no reports in the existing literature on this material about staining of restoring resins. Nevertheless the pigmentation of teeth and tongue leads to the supposition that such effects are possible on aesthetic materials, for these are quite sensitive to color alteration.

The presence of alcohol in the composition of some mouthrinse solutions may also be considered as a triggering factor of restorative materials staining. The alcohol probably acts as a facilitating agent for dye penetration in the resin [21]. This might explain the translucency alteration of resins when immersed in Fluordent Reach solution, which contains alcohol as one of its components.

Another substance found in one of the solutions (Fluorgard) is the phosphoric acid, which may possibly have an influence on translucency alteration of the materials tested in the present study, due to the superficial degradation that it causes on many dental materials. Asmussen and Hansen [22], in 1986, observed the effect of bacterial plaque's acid on composite resins surfaces and stated that acid causes alteration in superficial structure of resin and, consequently, it's staining. Even the application of acidulous phosphate fluoride on aesthetic materials also promotes a degradation of their surface, according to a study by Moura and Pinto [23]. In this way, it may be stated that the low pH of Fluorgard (pH = 4.2) promoted the action of red pigments on the translucency of the tested resins. Therefore, it is important, when using such flowable composite resins as restorative materials, to advise the patient not to use 0.05% sodium fluoride-containing solutions as daily mouthrinses. The professional must be aware of the solutions' characteristics and interactions with restorative materials, before indicating them to their patients.

5. Conclusions

Based on the findings of the conducted study, the following conclusions may be drawn:

- All the tested fluoride-containing solutions affected the translucency of the flowable composite resins.
- Fluorgard was the solution that most affected, for every condition of time, the translucency of the materials.
- Natural Flow showed the best performance under the experimental conditions purposed.

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