ORIGINAL RESEARCH

DOI: 10.2478/asmj-2022-0004

The behavior of aesthetic restoration materials under extreme conditions: in vitro study.

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Abstract

Introduction: Aesthetic materials for direct restorations can suffer changes in the oral cavity due to multiple factors acting at this level. The aim of the study was to demonstrate that aesthetic materials undergo structural changes in texture and chemicals, depending on the nature of the extrinsic factor, concentration, and exposure time. Material and methods: We used 3 types of composites, a self-polymerizing composite, two photo-polymerizing composites, and a glass ionomer. 210 teeth were initially immersed in artificial saliva as a control solution and afterwards immersed into artificial gastric juice, ethyl alcohol, energy drink, and distilled water. With the help of a pH meter, we determined the pH of the substances both before and after immersing the teeth in solutions. The teeth were monitored for 24-48 hours in a thermostat bath at 37 degrees Celsius, after which they were analyzed with the help of a rough meter that measures the smallest surface changes. Results: Significant changes in pH occurred in alcohol, where a considerable decrease was observed after 48h. Also, the alcohol produced the most aggressive changes of texture in the composites, and the smallest changes occured in the composite with nanofiller. The glass ionomer was the most affected of all the materials due to the exposure to both alcohol and artificial gastric juice, respectively energy drinks so that the surface analysis could not be performed. Conclusions: The results of the in vitro study are clinically important because the glass ionomer is much too rotten in these extreme situations. Thus, its use is not recommended both in patients with gastroesophageal reflux as well as in alcoholics and persons consuming energy drinks.

Keywords: aesthetic-materials, roughness, pH, resistance.

Introduction

The diet plays a decisive role in the lifetime of direct restorations. Dental erosion results from the loss of mineral salts from the tooth surface as a result of a chemical process of acid dissolution, with no microbial factor, involved [1]. According to new studies, the term erosion is being replaced with the term corrosion. The Chemical or electrochemical action is called “corrosion", due to both endogenous and exogenous factors [2]. One of the most essential endogenous sources of corrosion is bulimia, which produces a unique pattern of enamel loss. 'Perimolysis' is a type of corrosion marked on the palatal surfaces of the anterior maxillary teeth and, in more severe cases, on the buccal surfaces of the posterior teeth. The location on certain dental veneers highlights the position of the head during vomiting [3]. At the same time, in the case of the patient with gastroesophageal reflux disease, there is a loss of hard substance, but in smaller quantities. Demineralization of the tooth surface can also occur due to excessive consumption of acidic foods and sour drinks such as mangoes, citrus fruits, energy drinks, and sucking sour candies [4-6]. Alcohol abuse is also a factor that can not be neglected as it causes more significant corrosion following regurgitation and vomiting from gastritis associated with alcohol abuse [7,8].

Erosion is dependent on the action of the salivary glands respectively, on the production of saliva, which depending on the quantity and quality, influences the severity of demineralization [9].

Restorative materials used in dentistry must have long-term durability in the oral cavity, this is a complex environment in which the material is in constant contact with saliva and oral fluids. The most important physical properties of restoration materials are surface hardness, which correlates with compressive strength, abrasion resistance, and erosion [10].

The aim of the study

The aim of the study is to demonstrate that aesthetic materials undergo structural changes in texture and chemicals, depending on the nature of the extrinsic factor, concentration, and exposure time.

Material and methods

In the first part of the study, we analyzed three types of composite from a biochemical point of view, respectively Estelite Quick, Estelite Asteria OcE, and Evicrol. Estelite Quick is a light-curable composite indicated in anterior direct restorations, and composite veneers due to the nanofiller that gives it unique aesthetic qualities. Estelite Asteria OcE is also a light-curable composite, with superior resistance to Estelite Quick and improved aesthetic qualities, thus being indicated both in anterior restorations and in the posterior areas subjected to masticatory stress. Evicrol is part of the category of self-curing composites, with a low resistance to masticatory stress, so it is indicated only in the cavities of class III and V, respectively for certain defects of class IV.

We made a total of sixty perfectly adapted and calibrated tooth samples using a conformer that mimics the dental vestibular surface and allows the correct application of the composite in a uniform layer of 2mm. The composite resin was adapted in the conformer with a unique spatula from LM Dental, which does not allow the gluing of the material, respectively does not influence the chromatic stability of the composite resin. The light-curing was performed with the Bluphase Style lamp by Ivoclar Vivadent. From each type of resin were made twenty samples, ten with oxygen barrier, and ten without the oxygen barrier. The oxygen barrier is essential to prevent the over polymerization of the outer layer of the composite. In the case of the self-curing composite, we followed the manufacturer's instructions regarding the doses and the setting time. The composite samples were kept in distilled water to avoid dehydration of the resin until their application in substances.

The aggressive substances used to immerse the composite teeth were gastric juice and 90% pure alcohol and the, control solution used was artificial saliva (Figure 1). In six calibrated glass tubes, we added the composite samples, ten from each category, respectively with oxygen barrier and without barrier. In each tube we added 5 ml of aggressive solution, subsequently, all the tubes were incubated at 37 degrees Celsius (Figure 2).

For the biochemistry determinations, it was necessary to measure the initial pH of the substances used, respectively of the artificial saliva, of the artificial gastric juice, and of the pure alcohol, to have a standard. Subsequently, we performed dosing at 24h, 48h, and 96h from the immersion of the composite samples in substances, analyzing the pH changes obtained. The pH was determined using a pH meter (Figure 3).

In the second part of the study, we used three types of composite and glass ionomer cement. The samples (Figure 4) were perfectly adapted and calibrated, with a size of 10x10 mm and a thickness of 2 mm, made with the help of a silicone shaper. For the samples, we chose three types of composite and glass ionomer cement, respectively:

- Evicrol - self-curing composite with macro-filling;
- Filtek Z550 - light-curing composite with nanofillers;
- Estelite Quick - photo-polymerizable composite with nanofiller;
- Kavitan Plus - self-curing glass ionomer cement.

An essential step in obtaining the samples is the stage related to, the observance of the working protocol, respectively the correctness of performing the necessary steps. To fulfill this stage, we observed the doses recommended by each manufacturer regarding the powder: liquid ratio, respectively the time required for photo-polymerization.

The total number of composite tooth samples was 150, which were kept in distilled water to prevent dehydration until the moment of introduction into the substances. As in the case of biochemical dosing, we divided the samples into calibrated glass tubes, finally obtaining 24 tubes. 12 tubes have been preserved for 24 hours, and the other half for 48 hours. Each type of composite was assigned to three tubes, for gastric juice, alcohol, and energizer. In each tube, a quantity of 5ml of substance was introduced. After 24-48h incubation in the aggressive substances, the samples were attached to metal support to be analyzed. With the help of a rough meter, we analyze the composite sample on its entire surface. As a principle of operation, the rough-meter consisted of a fixed device with a movable metal rod that at the end had a fine blade, capable of recording the slightest changes in the surface. The specific unit of measurement used by the rough meter is RA 0.8x2 [Fig. 5].

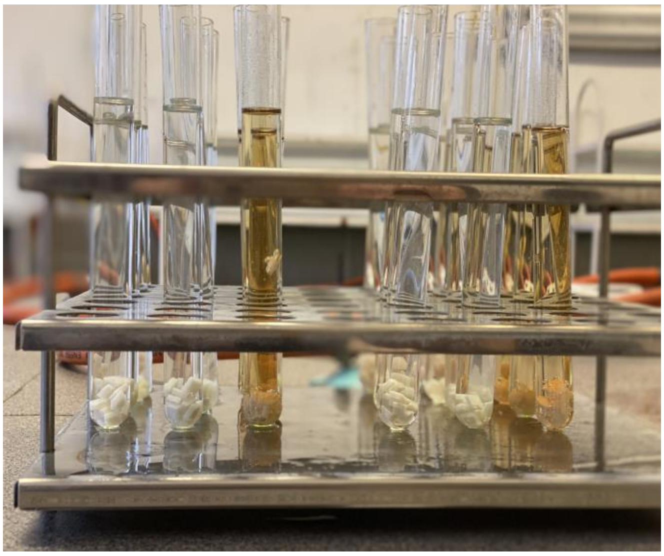

Figure 1. Samples in aggressive substances

Figure 2. Samples in the thermostatic bath at 37°C

Figure 3. pH determination

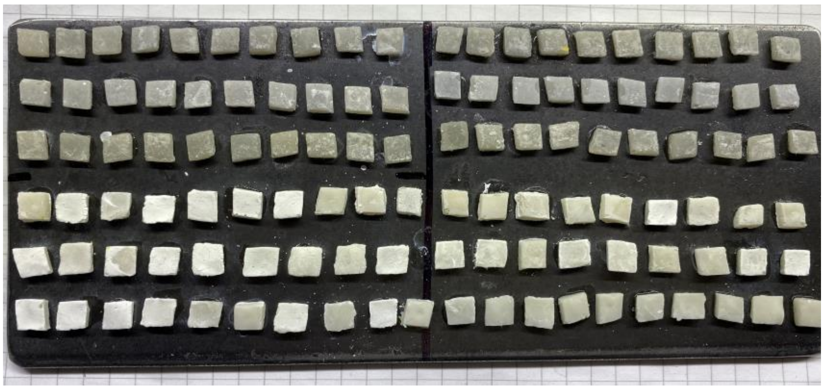

Figure 4. Composite samples

Figure 5. Rough-meter analysis

Results

The results can be divided into two categories, the results following the biochemical analysis with the help of the pH meter and the surface analysis with the help of the rough meter. Before the actual analysis, we determined the initial value of the pH of substances in which composite samples were introduced and we obtained the following values: saliva - 5.42, gastric juice - 2.26, alcohol - 8.7.

The pH analysis after 24 hours from the immersion of the samples in solution shows in the case of gastric juice a value of 2.60, reflecting a slight increase compared to the initial value, which reveals the stability of the sample in the aggressive solution in all 3 types of composites used, both with and without the oxygen barrier. In the case of samples introduced in alcohol, a drastic decrease is observed for the O2 barrier-free composite of 7.56, respectively a less marked decrease for the samples with oxygen barrier. After 48 hours from the immersion of the samples in solution, the analysis shows in the case of gastric juice the constant preservation of the pH value compared to the initial determination for Estelite Astera, respectively a slight decrease in pH in the case of the other 2 types of composite, the barrier of oxygen not influencing the values. In the case of alcohol, there is again a marked decrease in pH for samples without an oxygen barrier, which becomes a protective factor against alcohol. The pH analysis after 96h from the immersion of the samples demonstrated the preservation of the constant value compared to the previous analysis.

The analysis of the surface with the help of the roughness meter revealed the following changes:

- In the case of the Estelite Quick composite introduced in the gastric juice, we found minimum destruction of 1.33 RA 0.8x2 at 24h, respectively maximum destruction of 4.98 RA 0.8x2 at 48h. The samples introduced in alcohol suffered more significant destruction than those in gastric juice, with minimum destruction of 1.49 RA 0.8x2 at 24h and maximum destruction of 14,01 RA 0.8x2 at 48h. The energy drink had the mildest action on the samples with a change of 0.82 RA 0.8x2 at 24h, respectively maximum destruction of 3.96 at 48h.
- In the case of the Filtek Z550 composite introduced in the gastric juice, we found minimum destruction of 1.8 RA 0.8x2 at 24h after immersion, respectively maximum destruction of 10.88 RA 0.8x2, at 48h after immersion. The samples introduced in alcohol underwent minimum destruction of 2.78 RA 0.8x2 at 24h and maximum destruction of 10.77 RA 0.8x2 at 48h. The changes produced by the energizer were the smallest with minimum destruction of 0.39 RA 0.8x2 in 24 hours and maximum destruction of 3.14 RA 0.8x2.
- In the case of the self-curing composite Evicrol, the changes were significant both in the case of samples introduced in gastric juice and alcohol. High values were

recorded both 24 hours and 48 hours after immersion. The minimum destruction recorded was 3.53 RA 0.8x2, and the maximum 12.36 RA 0.8x2. Unfortunately, the glass ionomer samples introduced into the substances were very destroyed and could not be determined, due to the too rough surface.

Discussions

Contraction by the polymerization and the stress associated with them is a major factor governing the success of composite resin restoration. The stresses generated inside the composite resin due to the contraction polymerization process lead to the formation of microcracks on the surface of the composite [11]. The polymerization stress is considered one of the biggest disadvantages of the composite, which emphasizes the destruction of the surface at which it acts [12]. The results of this in vitro study support the hypothesis that the composite resins suffer changes caused by the storage environment and duration, which have a negative influence on the clinical performance and longevity of composite dental resin [13]. Two drinks with a high consumption rate - alcohol and energy drinks - respectively a product of an increasingly common pathology among the population - artificial gastric juice - were selected for the experiment. Significant differences in the micro-hardness and roughness of glass ionomer cement and composite resin immersed in various beverages were identified. Samples immersed in gastric juice and alcohol have undergone the most significant changes, which consist with the results of a similar study [14,15]. The decrease in surface microhardness observed after immersion of the samples (glass ionomer and composite resin) in alcohol, gastric juice, and energy drink may be associated with the hydrolytic degradation caused by these drinks. Water absorption causes a space between the linear chains of the expanding polymers and causes the loss of the chemical bond between the filler and the matrix. Thus, the nanoparticles move from the outer surface, causing a decrease in microhardness [16,17,18]. The increase in surface roughness, observed in glass ionomer cement, can increase bacterial infiltration and adhesion, allowing rapid colonization of microorganisms. Maturation of oral biofilm is associated with increased susceptibility to periodontal disease and dental caries, while color changes affect the aesthetics of restorations [19].

Filtek, a composite resin with nanofiller, with a particle size between 4-20nm compared to Ketak Applicable Universal resulting from mixing the powder with the liquid is much more resistant to bacterial infiltration and roughness is more limited due to its profilometric changes [20]. This study allows a better understanding of the effects of acidic beverages on dental materials, which specifies a certain limitation of them. The results are consistent with other studies, which evaluated different drinks with a low pH, thus proving the importance of this feature in the integrity overtime of dental restorations using direct aesthetic restoration materials. The composition of the materials is also a factor that should not be neglected when talking about the severity of the changes caused by acidic solutions, but other factors such as the presence of alcohol and oral hygiene must also be taken into consideration [21]

Conclusions

1. Direct restorative materials, despite the increased resistance, change as a result of the action of gastric juice, a clinically important aspect in people suffering from bulimia, or gastroesophageal reflux disease;
2. People consuming alcohol have an increased risk to develop chronic gastritis with increased gastroesophageal reflux, so at the level of the oral cavity two aggressive factors, alcohol and gastric juice will simultaneously act on the restorative materials;
3. Energy drinks produce a less significant change on the surface of restoration materials;
4. The restorative material used for people with different pathologies must be chosen with great care, the glass ionomer being contraindicated due to its low resistance.
5. The clearance of saliva influences the severity of the destruction of the surfaces of the restoration materials.

Conflict of interest: None declared.

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Received: November 11, 2021 / Accepted: January 18, 2022