Abstract

The present study evaluates the erosion effect of some antiseptic acid solutions used in oral rinsing, as well as of the frequent intake of acid beverages upon various types of composite resins.

To this end, two composite resins - namely Filtek Z250 (3M ESPE) and Charisma (Heraeus Kulzer), out of which 10 mm in diameter and 4 mm high cylindrical samples were prepared, were used. For each type of material, the samples were randomly divided into 5 groups, according to the solutions in which they had been immersed: distilled water (reference samples), tea (Nestea Lemon), Coca Cola, Corsodyl and Listerine, then analyzed by atomic force microscopy. A marked tendency of increased surface rugosity of both hybrid and microhybrid resins could be noticed after immersion in acid solutions. Statistically significant results were obtained when comparing the values of rugosity recorded after immersion of the Z250 and Charisma composite resins in Coca Cola, Listerine, Corsodyl and Nestea Lemon, comparatively with the reference group, as well as among the rugosity values obtained after immersion in Coca Cola, Nestea Lemon, Corsodyl and Listerine, with the exception of the values recorded after immersion in Nestea Lemon and Listerine.

Under the experimental conditions applied in the present study, surface rugosity of composite resins was influenced - whichever their type - by their immersion in an acid medium. For both types of composite resins under investigation, the most aggressive medium was that of Coca Cola, followed, in decreasing order, by Nestea Lemon, Listerine and Corsodyl.

Keywords: composite resins, acid solutions, AFM

INTRODUCTION

The behaviour of composite restorations is dictated by their physical and mechanical properties, even if, when performing an obturation, the extent of their biodegradation in the oral cavity, where the action of humidity and the pH are also manifesting, should be considered. Biodegradation is a complex phenomenon which may destroy the polymeric matrix, causing severe problems, such as its detachment off the mineral filler, which is accompanied by the release of residual monomers, abrasion and erosion induced by food, which may finally favorize bacterial activity. Such processes alter the mechanical properties of the composite, thus reducing the life time of obturation. More than that, disintegration of the obturation surface increases bacterial plaque retention and the risk of secondary carious lesions.

Previous studies have shown that, under acid conditions, composite resins may be modified (1). Some substances, considered as being acid because of their low pH, may act as extrinsic agents for dental erosion or for the restorations made with composite resins, especially when frequently used. This occurs mainly in subjects affected by chronic diseases, who use oral-administered drugs with erosion potential, or in persons with a habitual intake of acid food or beverages.

The present study evaluates the erosion effect upon various types of composite resins as a result of some antiseptic acid solutions employed for oral rinsing, and of certain acid beverages frequently intaken.

MATERIALS AND METHOD

Two composite resins with different filler size, a microhybrid (Filtek Z250 3M ESPE) and a hybrid (Charisma, Heraeus Kulzer) one - were used, from which 10 mm in diameter and 4 mm high cylindrical samples were prepared.
Each 2 mm thick layer of material was photopolymerized for 40 sec, with a LED (LED.B, Guilin Woodpwcker Medical Instrument Co., Ltd, China) lamp. For each type of material, the samples were randomly divided into 5 groups, then introduced into distilled water (the reference), in tea (Nestea Lemon), Coca Cola, Corsodyl and Listerine. The samples were immersed in solutions for 14 days, for solutions used for oral rinsing (Corsodyl and Listerine), and for 30 days, respectively, for acid beverages like Nestea Lemon and Coca Cola. The sections were introduced into an ultrasonic bath for 10 min, then vacuum-dried and finally studied by atomic force microscopy. Surface rugosity of the samples was calculated, the results being expressed as values of quadratic rugosity.

RESULTS

The values of quadratic rugosity recorded for the hybrid composite resin Charisma, following its immersion into distilled water, Coca Cola, Listerine, Corsodyl and Nestea, are listed in Table I.

<table>
<thead>
<tr>
<th>Roughness (µm)</th>
<th>Distilled water</th>
<th>Coca Cola</th>
<th>Nestea</th>
<th>Listerine</th>
<th>Corsodyl</th>
</tr>
</thead>
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<tr>
<td>1.17</td>
<td>3.50</td>
<td>3.43</td>
<td>3.38</td>
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</tr>
<tr>
<td>1.16</td>
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<td>3.36</td>
<td>3.34</td>
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<td>3.39</td>
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</tr>
<tr>
<td>1.17</td>
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<td>3.37</td>
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<td>1.16</td>
<td>3.49</td>
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<tr>
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<td>3.52</td>
<td>3.34</td>
<td>3.38</td>
<td>3.32</td>
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</tr>
</tbody>
</table>

A marked increasing tendency towards surface rugosity of the hybrid composite resin was noticed after its immersion in acid solutions. From an average rugosity value of 1.17 in samples immersed into distilled water, the values increase to 3.32, when immersed into Corsodyl, to 3.38 and 3.39 - in Listerine and Nestea, respectively, up to 3.51, when immersed into Coca Cola.

The values of quadratic rugosity recorded for the Z250 microhybrid composite resin, following its immersion into distilled water, Coca Cola, Listerine, Corsodyl and Nestea, are recorded in Table II.

<table>
<thead>
<tr>
<th>Roughness (µm)</th>
<th>Distilled water</th>
<th>Coca Cola</th>
<th>Nestea</th>
<th>Listerine</th>
<th>Corsodyl</th>
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</thead>
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<td>3.28</td>
<td>3.14</td>
<td></td>
</tr>
</tbody>
</table>

The same marked increasing tendency towards surface rugosity of the microhybrid composite resin after its immersion into acid solutions was noted, as follows: from an average rugosity value of 1.11 in samples immersed into distilled water, the values increase to 3.14 in the case of Corsodyl immersion, from 3.28 and 3.29 in Listerine and, respectively, Nestea immersion, up to 3.45 in the case of Coca Cola.

Aspects of AFM examination for samples taken over from the two materials, following their immersion into the 5 solutions, are illustrated graphically in Figure 1.

Figure 1. AFM aspects of the two composite resins after immersion in solutions

For each of the 5 immersion solutions, the rugosity values recorded for the two types of composite resins used were different. The obtained data were statistically analyzed using the Wilcoxon test, to get any possible statistical significance of the differences noted in the rugosity.
values of the two types of materials, following their immersion into acid solutions.

Statistically significant results were obtained when comparing the rugosity values recorded after immersion of the Z250 and Charisma composite resins into Coca Cola, Listerine, Corsodyl and Nestea Lemon, comparatively with the reference, as well as when comparing the rugosity values obtained after immersion into Coca Cola, Nestea Lemon, Corsodyl and Listerine among them, with the exception of the values obtained after immersion into Nestea Lemon and Listerine (Tables III, IV).

Large-scale use of obturation materials of the composite resin type and their exposure to the usually hostile conditions present in the oral cavity require a higher resistance of theirs to degradation. Both composites used in the present study evidenced surface degradation after immersion into acid substances, which may affect the mechanical and physical properties of the materials, thus creating favourable conditions for bacterial colonization.

Food or beverages (such as soft or alcoholic drinks or some other food derivatives) may affect the behaviour of the restoration materials (1,2). Several soft drinks have a pH = 3 or even lower, which means that, drunk for long periods, they may cause erosion of both enamel and composite resins. Some previous studies have demonstrated that the microfiller particles tend to be eliminated from the resin (3), while the components of the organic matrix get decomposed when occurring in a medium with a low pH (4,5). The acidity mechanism at the level of the composite resin may be explained by the hydrolysis of the ester radicals present at the level of dimethylacrylate monomers (Bis-GMA, Bis-EMA, UDMA, TEGDMA). For all samples under analysis, electronic microscopy showed the presence of mineral particles prominent on the surface, which demonstrates alteration of the organic matrix. Wongkhanter et al. (1) noted a lower resistance to the acid attack in the case of composites with microfilling, comparatively with the universal hybrid ones, which may be explained by the presence of a higher amount of organic matrix in microfiller composites. Composite resin Z250 contains an organic element, made of Bis-GMA, and of an UDMA and Bis-EMA.
mixture. These resins have higher molecular weight, which reduces polymerization contraction and also the ageing effect of the material. Charisma is a traditional composite, obtained according to Bowen formula, containing the following monomers: Bis-GMA and TEGDMA. In the present study, the TEGDMA organic resin appeared as less resistant to the acid attack, comparatively with the Bis-GMA, UDMA and Bis-EMA mixtures.

An extremely important part is also played by the coupling agent which, to some extent, protects the filler against degradation through hydrolysis (6). Another possible cause of the degradation of composites surface is due to the fact that the fillers and the matrix are too weakly linked, which may be correlated with an insufficient treatment of the filler surface with silan, leading to filler erosion (7, 8).

Previous studies demonstrated that the resistance of composite resins to the acid attack is higher in those with a higher mineral particle load (9). The mineral particles are not eliminated from the material if the resin filling the spaces between fillers is not sufficiently exposed. Z250 is filled in a 60% volumetric ratio with zirconium-silicon particles with sizes varying between 0.01 and 3.5 micrones. Charisma is a typical hybrid composite resin. The average value of the mineral particles is of 0.7 micrones, while their maximum value is of 2 micrones. The material also included two different fractions of fillers, which confer different composition and size to the particles, namely: barium microglass with compact structure and amorphous shape and silicon oxide (0.01-0.07 micrones). In the present study, both materials had a comparable mineral loading, which does not justify the presence of some significant behavioural differences in the two materials. Apart from their mineral particle content, filler’s properties, its distribution and the treatment of filler’s surface through silanization, also act as important factors on composites resistance to erosion.

The extent of alteration of composite resin surfaces is also correlated with the acidity level of the solution in which they had been immersed. In the case of Coca Cola, pH= 2.6. Such a low acidity is given by the phosphoric acid, added to make the drink more tasty, and also to the carbon dioxide, which is transformed into carbonic acid. The pH of the soft drink Nestea is 3.6. According to the official information provided by the producer, Phizer, the original formula of the Listerine solution for oral rinsings, containing 26.9% alcohol, has a pH = 4.2. Composition of the Corsodyl solution for oral rinsings contains 96% ethanol, castor oil, sorbytol, mint oil, purified water, the pH recording a value of 5.6. The results of the present study demonstrated the increasing tendency of rugosity in both types of composite resins with the increase of the solution pH. In spite of the fact that previous studies considered the pH as indicative of solution acidity, this parameter provides information regarding exclusively the initial concentration of the H⁺ ions, and no data related to the acid non-dissociated in the medium. On the other hand, titrable acidity may be viewed as a more faithful parameter for measuring the total content of acid present in the substances, and for realistically expressing their erosion effect.

CONCLUSIONS

Under the experimental conditions used in the present study, one may conclude that surface rugosity of composite resins, whichever their type, was altered, their immersion into an acid medium causing surface degradation. For both types of composite resins under analysis, the most aggressive medium was that of Coca Cola, followed, in decreasing order, by Nestea Lemon, Listerine and Corsodyl.

References

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