Effect of three types of mouth rinses and human saliva on microhardness of packable and nanocomposite resins (In vitro study)

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ABSTRACT

Background: The purpose of this in vitro study was to evaluate and compare the influence of three types of mouth rinses on the microhardness of two types of composite resins (packable and nanofilled composite).

Materials and Methods: Total numbers of 64 specimens were prepared, using molds specially fabricated for this study and divided according to type of composite resins used, into two groups: 32 specimens made from Filtek P60 and 32 specimens made from Filtek Supreme XT nanocomposite. Then each 32 specimens subdivided into 4 subgroups according to treatment solutions used (Listerine, oral-B, chlorhexidine containing mouth rinses and saliva). The specimens of each subgroup was immersed, after curing, in distilled water for 24hr at 37°C then subjected to microhardness measurement for baseline readings determination using Vickers microhardness tester. Then each subgroup was immersed in 20 ml of treatment solutions and incubated at 37°C for 24 hr and re-subjected to microhardness measurement. The change in hardness value was calculated for each sample. The resulting data were statistically analyzed using ANOVA and t-test at a 0.05 significance level.

Results: The results revealed that, all mouth rinses tested decreased the hardness of both tested resins-composites and non significant reduction in microhardness with saliva.

Conclusion: Both alcohol-containing & alcohol-free mouth rinses cause, highly significant reduction in microhardness of composite resins while saliva causes non significant reduction in microhardness. Chlorhexidine-containing mouth rinses highly significantly decrease the hardness of nanocomposite and significantly decrease the hardness of packable composite.

Keywords: Mouth rinses, saliva, composite resins, vicker's microhardness.

INTRODUCTION

For effective prevention and control of caries and periodontal disease, bacterial plaque must be removed from all surfaces of the teeth but there is difficulty of achieving acceptable levels of plaque control with mechanical means, the use of mouth

rinses is highly appealing to patients and clinicians. Alcohol is used in mouth rinses to dissolve other ingredients and plaque with antisepitic properties. Alcohol in mouth rinses may also soften composite restorations. This softening effect was found to be directly related to the percentage of alcohol in the mouth rinses; however, both alcohol-containing and alcohol-free mouth rinses can reduce the hardness of the restorative materials. Alcohol content is not the only factor that has a softening effect on composites. Saliva, chlorhexidine, fluoride, food
components and beverages have been found to soften dental composites and reduce hardness of material\(^4\).

Therefore this, an in vitro study, is done to evaluate the effect of mouth rinses and human saliva on microhardness of recent types of composite resins, nanofilled and packable composites.

**MATERIALS AND METHODS**

**Specimens’ preparation**

A total of 64 specimens were prepared, by placement of plastic mold on flat microscopic glass slide on top of a celluloid strip\(^5\), and then resins were inserted into the mold, in a single increment with slight excess using plastic instrument. The material was covered with a celluloid strip, another glass slide was placed over the strip\(^6\) under a weight of 200 g for 1 min until the slide touched the mold completely, thus allowing excess composite to flow prior to curing\(^7\).

All specimens were polymerized by QTH light curing unit with a light intensity 400-450 mW/cm\(^2\), for 20 sec. of exposure time to top and bottom surfaces, respectively. The distance between the light source and the specimen was standardized by using 1 mm glass slide\(^8\). The output of the curing units was checked with a radiometer. The celluloid strips were removed and the top surfaces of specimens would be marked\(^9\) by nail varnish for identification the top surface from the bottom surface.

The polymerized specimens were removed from the mold by pressing on the specimen from one surface. Excess materials were eliminated with a scalpel blade\(^10\). The thickness was checked by vernier\(^11\).

Each specimen was polished by composan polyester abrasive strips start with medium size (gritting 60 micron) then fine (40 micron), fine (30 micron) and finally super fine (12 micron). Polishing time was about 30 sec for each strip\(^12\).

**Grouping of the specimens for base line measurements:**

The 64 specimens were divided into two main groups, 32 specimens each, according to type of resin-composites used. Then each group subdivided according to type of treatment solution, in to four subgroups. The specimens of each subgroup were immersed in 20 ml of distilled water (pH = 7.53) in dark bottle for 24 hours at 37\(^\circ\) C prior to baseline assessment\(^13\).

The specimens were removed from distilled water using a twizer and blotted dry using tissue papers. The baseline microhardness values of the specimens were determined using a Vicker's microhardness tester (Micromet microhardness tester, USA). The results obtained are considered baseline records for each specimen\(^14\).

**Immersion of the Specimens in the Treatment Solution:**

All specimens were removed after 24 hours of their immersion in treatment solution and incubation. 20 ml of distilled water (pH=7.53) was used to thoroughly rinse each specimens for 120s. Each specimen was then blotted dry using a filter paper\(^15\) and then subjected to microhardness measurement. The changes in hardness value between the baseline and after treatment measurement were calculated according to the following equation\(^14\):

\[
\Delta \text{VHN} = VHN \text{ (after treatment)} - VHN \text{ (baseline measurement)}
\]

The recorded data for the microhardness measurement were collected and statistically analyzed between the subgroups and groups using ANOVA and T-test.

<table>
<thead>
<tr>
<th>Material</th>
<th>Type</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filtek™ P60</td>
<td>Packable composite</td>
<td>(3M ESPE, St. Paul, MN, USA)</td>
</tr>
<tr>
<td>Posterior</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restorative</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Filtek™ Supreme</td>
<td>Nano-composite</td>
<td>(3M ESPE, St. Paul, MN, USA)</td>
</tr>
<tr>
<td>XT Universal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restorative</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2: Types of the treatment solutions used in the study.

<table>
<thead>
<tr>
<th>Treatment solution</th>
<th>Composition</th>
<th>manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Listerine With Tarter Production</td>
<td>Eucalyptol 0.092%, menthol 0.042%, Menthol Salicylate, Thymol, Water, Alcohol (Ethanol) (21.6%), Sorbitol, Flavoring, Poloxamer 407, Benzoic Acid, Zinc Chloride, Sucralose, Sodium Benzoate, FD&amp;C yellow No. 6, FD&amp;C red no. 40</td>
<td>Johnson &amp; Johnson Healthcare Products, Skillmann, USA</td>
</tr>
<tr>
<td>Oral-B Alcohol-free</td>
<td>Aqua, Glycerin, Polysorbate 20, Aroma, Methylparaben, Cetylpyridinium Chloride, Sodium Fluoride, Sodium Saccharin, Sodium Benzoate, Propylparaben, Cl 42051.</td>
<td>Procter &amp; Gamble UK, Weybridge, Surrey, KT13 0XP, UK.</td>
</tr>
<tr>
<td>Corsodyl mint mouth wash</td>
<td>0.2% chlorhexidine gluconate</td>
<td>GlaxoSmithKline Consumer Healthcare, Brentford, TW8 9GS, UK.</td>
</tr>
<tr>
<td>Saliva</td>
<td>Unstimulated Human Saliva</td>
<td></td>
</tr>
</tbody>
</table>

RESULT

ANOVA test revealed, there was a highly significant difference HS (P<0.0001) among the different subgroups of packable P60 and nanocomposite groups. T-test compare between the mean of VHN values before & after immersion in both types of composite resins in treatment solutions, the results showed highly significant difference (P<0.0001) in these values after immersion in Listerine and oral-B mouth rinses, but with chlorhexidine-containing mouth rinses the reduction in VHN value was significant S (P<0.05) in packable P60 and highly significant reduction in nanocomposite, but with saliva subgroup the reduction was non significant NS (P>0.05) for both composite resins types (Table 3 and Table 4). When we compare between Filtek P60 and Filtek Supreme XT in ΔVHN values for all subgroups using t-test, the result showed that highly significant differences between two composite resins (Figure 1 and Table 5).

Table 3: t-test comparing between the mean of VHN values before & after immersion in treatment solution & for all subgroups of Filtek P60.

<table>
<thead>
<tr>
<th>Sig</th>
<th>P-value</th>
<th>t-test</th>
<th>subgroups</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS</td>
<td>0.0000</td>
<td>11.80</td>
<td>Listerine</td>
</tr>
<tr>
<td>HS</td>
<td>0.0000</td>
<td>10.09</td>
<td>Oral-B</td>
</tr>
<tr>
<td>S</td>
<td>0.041</td>
<td>2.35</td>
<td>Chlor-hexidine</td>
</tr>
<tr>
<td>NS</td>
<td>0.13</td>
<td>1.58</td>
<td>Saliva</td>
</tr>
</tbody>
</table>

Table 4: t-test comparing between the mean of VHN values before & after immersion in treatment solution & for all subgroups of Filtek Supreme XT.

<table>
<thead>
<tr>
<th>Sig</th>
<th>P-value</th>
<th>t-test</th>
<th>subgroups</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS</td>
<td>0.0000</td>
<td>7.17</td>
<td>Listerine</td>
</tr>
<tr>
<td>HS</td>
<td>0.0000</td>
<td>8.61</td>
<td>Oral-B</td>
</tr>
<tr>
<td>S</td>
<td>0.0000</td>
<td>9.89</td>
<td>Chlor-hexidine</td>
</tr>
<tr>
<td>NS</td>
<td>0.168</td>
<td>1.45</td>
<td>Saliva</td>
</tr>
</tbody>
</table>

DISCUSSION

Hardness is the resistance of material to indentation, and it correlates well to material’s strength and rigidity, while the microhardness is non destructive laboratorial test specifically located, that supplies fundamental data about the material. When we compare between Filtek P60 and Filtek Supreme XT in ΔVHN values for all subgroups using t-test, the result showed that there are two variables present in
this study, treatment solutions and composite resins, and each one differently effect on the results. Highly significant differences occurred between VHN values before and after immersion of Packable P60 & Filtek Supreme XT in Listerine mouth rinse that contain alcohol (ethanol) about (21.6%). Both Bis-GMA and UDMA-based polymers are susceptible to chemical softening by ethanol. High alcohol containing mouth rinses, such as Listerine, soften composite resins with irreversible leaching of material components in the presence of ethanol.

Listerine have low pH (4.2) because containing benzoic Acid with high alcohol percentage, these ingredients greatly affects the hardness of resin-composites. Low PH increase resin composite biodegradation over time. This phenomenon is a complex process that may lead the composite polymer matrix to collapse, causing several problems such as filler-polymer matrix debonding, release of residual monomers, wear and erosion caused by food, chewing and bacterial activity. This process may deteriorate the mechanical properties of the material and reduce the clinical life of composite resin restorations. Although Oral-B mouth rinses is alcohol free, it exhibited highly significant decrease in VHN values in both composite resins. Alcohol is not the only factor that has a softening effect on the restorative materials. Other ingredients in mouth rinses such as solvents, fluoride and acids may have softening effect on polymer matrix. Oral-B mouth rinses contain sodium fluoride as an active ingredient which causes surface degradation and reduction in hardness of composite resin. Reduction of microhardness of composite resins in subgroup 3 may be related to low PH of chlorhexidine or effect of additive, while Saliva causes non significant reduction in mean VHN values, this result may be due to little immersion time which equal only to 24 hrs presences of composite resins in mouth.

When compare between packable P60 and nanocomposite, the results found higher susceptibility of nanocomposite to chemical degradation and reduction in microhardness by all treatment solutions. These results may be related to types of monomers commonly used in dental composite resins, water sorption decreases in the following order: TEGDMA>Bis-GMA>UDMA. These monomers have hydrophilic ether linkages (TEGDMA), hydroxyl groups (Bis-GMA), and urethane linkages (UDMA). Bis-EMA (ethoxylated Bis-GMA) has low water sorption ability because it does not contain the hydroxyl group. According to the manufacturers the resin system of Filtek Supreme XT consists of hydrophilic monomer TEGDMA with a blend of UDMA and Bis-EMA, while the resin system of Filtek P60 consists primarily of: Bis-GMA, UDMA and Bis-EMA. Absorption of water or solvent of mouth rinse cause degradation and erosion of methacylate based composite resin materials, weakness of the polymer and decrease of their mechanical properties.

The effect of mouth rinses, on microhardness of composite resins, is too little when it compared with human saliva, because immersion of specimens in mouth rinses for 24 hours is equivalent in time to 1 year of 4 min. daily use of mouth rinse while the effect of saliva for 24 hrs immersion time is equal to one day only presence of specimens in mouth, and we suspected higher effect of saliva when the immersion time increase.

REFERENCES