Surface roughness and surface hardness changes in composite resin provisional crown before and after brushing with whitening toothpaste

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Abstract

Objective: To determine the surface roughness and surface hardness difference in composite resin provisional crown before and after brushing with whitening toothpaste.

Material and Methods: This was a pre- and post-test group design experimental study. In this study, the sample was a composite resin provisional crown based on bis-acryl. The number of samples in this study was 32 samples, 16 for the surface roughness test and the other 16 for the surface hardness test. Each sample was brushed using a VB-Brushing Machine Modified, then tested for surface roughness and hardness using a Profilometer and Vickers Hardness Tester.

Results: The paired T test was used to analyze the results statistically. There was a significant difference between the groups before and after brushing with whitening toothpaste. (p<0.05).

Conclusion: After simulated brushing with whitening toothpaste, there was a change in the provisional crown material surface roughness and hardness value.

Keywords: Provisional crown, Surface hardness, Surface roughness, Whitening toothpaste

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Introduction

Provisional crown is a fixed dental prosthesis that improves stability and/or function for a short period of time. This type of crown is applied until the final crown is made. Provisional crown was generally fabricated from acrylic resin or composite resin. Composite resin was developed to overcome the weakness of acrylic resin. The development of composite resin base materials that utilize fillers is expected to increase hardness, reduce thermal expansion, and reduce polymerization shrinkage. Although this material has many advantages, composite resins also have weaknesses in abrasive resistance. Nowadays, the aesthetic needs of society encourage people to choose toothpaste that supports cosmetics aspects, especially those containing whitening agents. Whitening toothpaste, in general, has additional ingredients such as bleaching and more abrasive ingredients.

Material and Methods

This study was approved by research ethics committee of Universitas Sumatera Utara (Number: 862/KEP/USU/2020). This was an experimental study that used a pre- and post-test group design. The sample was a composite resin provisional crown based on bis-acryl. The number of samples in this study was 32 samples (12x20x10 mm), 16 for the surface roughness test and the other 16 for the surface hardness test. The resin blocks were fabricated with auto-polymerized acrylic resin. Each block was drilled in the center to create a cylindrical cavity (10 mm in diameter and 2 mm in depth). The provisional crown material was inserted into the cavity and covered with a celluloid strip while it polymerized completely. After all of the samples had hardened, the surface was polished using abrasive paper with grit numbers of #1000 and #1200 to standardize the surface before measuring the surface roughness and hardness.
Shimadzu, Japan) was used to measure surface hardness through a polished surface loaded by a pyramid-shaped indenter with a 136° peak of angle. The surface is subjected to a 100 gf load with 15 seconds pressing time through the pyramidal indenter. The resulting indentation is measured under a microscope which is automatically connected to the microscope. Measurements were carried out three times, and the average value was taken.

The Statistical Package for the Social Sciences version 20.0 (SPSS, Inc., Chicago, IL, USA) software was used to process the data, which was then analyzed with the T paired test. P value of less than 0.05 were considered statistically significant.

Surface roughness

A paired T-test was used to compare the surface roughness of the composite resin crown material before and after brushing with whitening toothpaste. Prior to testing with the paired T-test, the distribution of the data was checked by using the Shapiro-Wilk test to ensure that the data was normal. The significance of the T-test results in the group before and after brushing was p = 0.0001 (p<0.05). This demonstrates a significant difference between the groups before and after using whitening toothpaste table 1.

Surface hardness

The results of the paired T test in the group before and after brushing obtained a significant different (p <0.05). This shows a significant different in before and after brushing groups with whitening toothpaste table 2.

Results

Surface roughness

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Surface hardness

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Table 1. The difference in surface roughness of composite resin provisional crown materials before and after brushing with whitening toothpaste

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>x ± SD</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before brushing</td>
<td>16</td>
<td>0.24 ± 0.04</td>
<td>0.0001*</td>
</tr>
<tr>
<td>After brushing</td>
<td>16</td>
<td>0.30 ± 0.07</td>
<td></td>
</tr>
</tbody>
</table>

Table 2. The difference in surface hardness of composite resin provisional crown materials before and after brushing with whitening toothpaste

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>x ± SD</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before brushing</td>
<td>16</td>
<td>32.29 ± 3.30</td>
<td>0.0001*</td>
</tr>
<tr>
<td>After brushing</td>
<td>16</td>
<td>26.52 ± 1.79</td>
<td></td>
</tr>
</tbody>
</table>

Discussion

Surface roughness

After brushing with whitening toothpaste, the value of surface roughness increased in this study. The findings of this study back up prior research that shown that brushing with whitening toothpaste can increase surface roughness. The surface roughness value will increase gradually along with the brushing cycle, which has a wear/abrasive effect on the sample surface. Previous studies have shown that brushing the restoration surface with toothpaste for 1 hour can cause more abrasion than brushing with water for 6 hours. This shows that the type of toothpaste is an essential factor in the level of surface damage to the composite resin.

Discussion

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study used a whitening toothpaste with a high level of abrasiveness (110 RDA). The whitening toothpaste in this study contains the abrasives of Hydrogen Peroxide and Silica, which can cause the softer resin matrix to erode, causing the filler particles to be exposed. The combination of abrasives and suppression of brushing can cause dislodgement or breakage of the relationship between the matrix and filler. Hydrogen Peroxide and Silica with large particle sizes and irregular particle shapes can break the relationship between matrix and filler.

**Surface Hardness**

Hardness is the surface property of restorative material to resist deformation. The Vickers Hardness Test is a microhardness test commonly used to test the surface hardness of restorative material. In the Vickers Hardness Test, very accurate readings can be done, and the indenter can be used to test all types of materials regardless of hardness. The indenter used is small so that it can reduce the risk of damage to the sample. The Vickers hardness test is particularly suitable for testing the softest and stiffest materials under varying loads. Based on the above reasons, the Vickers hardness test was chosen for this study.

The results of this study revealed that after brushing with whitening toothpaste, the groups had a substantial change in surface hardness. Whitening toothpaste has a mechanical abrasive impact due to the abrasive chemicals in it. Carbonates, phosphates, silica, and other agents such as alumina, clays, and oxides are the four types of abrasives present in toothpaste. The toothpaste used in this study contains silica abrasive. Silica is more abrasive than the other categories, according to prior studies.

Hardness values showed significant differences depending on the type of composite resin used in previous studies. This differentiation is due to each material’s composition and filler. The lower the surface hardness value, the less filler content in the composite resin. Surface hardness variations in composite resins usually occur within the first seven days after chemical exposure. The hardness of the surface was measured and treated immediately after polymerization in this study. After brushing with whitening toothpaste, the results of this study demonstrated a statistically significant decrease in surface hardness. Because whitening toothpaste is abrasive, it can induce more alterations in the exposed sample’s surface hardness. Previous study stated that toothpaste in ingredients could change the surface characteristics of the composite resin. The difference in surface hardness can be explained by the chemical degradation of the composite surface in relation to the resin matrix. However, due to the material’s high sensitivity to water absorption, the hydrolytic instability of the organic matrix is regarded as the most brittle point of the composite resin, which may result in alterations.

Water absorption occurs in the composite resin matrix through the diffusion of water molecules into the empty spaces between the polymer chains, causing the polymer to expand because the polymer molecules are pushed aside (expanded). This will cause the atoms to become unstable so that it is easy to change dimensions. Furthermore, polymers with a carboxyl group bonded with water form weak hydrogen bonds, which can then be released and damage the polymer matrix and filler components, affecting the surface hardness.

According to E.K Hansen, water absorption and contact duration with aqueous media can have a considerable impact on the surface hardness of composite resins. Water absorption is significantly influenced by the monomer’s chemical characteristics. In their research, KB Roopa et al. stated that the effect of whitening toothpaste on surface hardness is time and material-dependent. Therefore, a more significant decrease in hardness is seen with increasing time. Reduced surface hardness might cause anatomical form loss and discoloration in the clinical environment. Furthermore, chemical softening might increase wear and abrasion, reducing the lifespan of the temporary crown material.

Increasing the value of surface roughness and decreasing the value of surface hardness can increase the retention of plaque, bacteria and food debris, causing gingival irritation, secondary caries, and wear and tear on adjacent and opposing teeth. The loss of anatomical shape and discoloration of the temporary crown used by the patient impacts the service life and reduces the aesthetic value of the temporary crown. In patients prone to abrasion, it can be advised to use toothpaste with a high level of abrasiveness or replace toothpaste with a lower level of abrasiveness.

**Conclusion**

Despite the study’s limitations, it can be stated that the surface roughness and hardness of the composite resin provisional crown material differ before and after brushing with whitening toothpaste.
Acknowledgment
None.

Conflict of Interest
The authors report no conflict of interest.

References