The difference between one-step polishing systems on surface roughness, microhardness, and color stability of bulk-fill composite resin

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ABSTRACT

Background: The polishing procedure was an important step in composite resin restoration as it reduces restoration surface roughness. Smooth and well-polished restoration surfaces can increase microhardness and minimize discoloration on the tooth surface. The study aims to examine the differences of one-step polishing systems on surface roughness, microhardness, and color stability of bulk-fill composite resin.

Method: The samples were bulk-fill composite resin moulded with 4 mm of diameter and thickness (n=30) for microhardness (n=15) and surface roughness (n=15) test and moulded with 6 mm of diameter and 4 mm of thickness for color stability (n=15) test. The samples were divided into three groups consisting of 5 samples for each variable and were polished using PoGo, OptraPol, and OneGloss. Color stability test samples were immersed in tea solution for 7 days. Color stability measurement was done by comparing the results of color measurements using a spectrophotometer before and after immersion. Microhardness was tested using Vickers Microhardness Tester, while surface roughness was tested using the Stylus Profilometer Fowler Surfcorder SE1700.

Result: The data analysis showed that PoGo produced the smoothest surface roughness significantly (p=0.006), the highest microhardness significantly (p=0.002), and the lowest color change significantly (p = 0.027)

Conclusion: PoGo produced lowest surface roughness and color change, and highest microhardness compare with OptraPol and OneGloss.

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INTRODUCTION

Composite resin is the most widely used dental restorative material due to its color, good durability, and its ability to be manipulated. However, the composite resin has a weakness, including polymerization shrinkage. Polymerization shrinkage is a contraction that occurs in the composite resin during the polymerization process, causing a marginal gap between the composite resin and the tooth structure. The marginal gap can cause secondary caries, staining, fracture of the cusp, and post-restorative pain. One technique to reduce polymerization shrinkage is the incremental technique.

The incremental technique is a technique for applying composite resins in layers. This technique’s weakness includes prolonged clinical procedure and the risk of forming voids between layers. Bulk fill composite resin is developed to overcome the shortcomings of conventional composite resin. Bulk fill composite resin can be applied into a cavity up to 4 mm in one application.

The polishing procedures provide a smooth and glossy restoration surface, and affect the marginal bond of the composite resin. The use of a polishing instrument can reduce surface roughness, minimize tooth discoloration, and increase microhardness. Like conventional composites, the importance of polishing procedure was also in bulk-fill composite resin because the roughness and irregular surface lead to plaque accumulation, gingival inflammation, superficial staining, and secondary caries.

The polishing instrument can be carbide bur, diamond point, abrasive disc, abrasive finishing strips, and polishing pastes. There are two types of polishing tools, the multi-step polishing system and the one-step polishing system. The multi-step polishing system is a polishing instrument with various roughness levels, while the one-step polishing system has only one polishing tool. PoGo, OptraPol, and OneGloss are one-step polishing systems. This study aims to examine the differences between various one-step polishing tools on surface roughness, microhardness, and color stability of bulk-fill composite resins.

RESEARCH METHOD

Specimens

The specimens were bulk-fill composite resin molded with a diameter of 6 mm and a thickness of 4 mm for the color test (n=15), as well as a diameter of 4 mm and a thickness of 4 mm for the microhardness test (n=15) and surface roughness (n=15). The microscope glass slide was placed on the top and the bottom of the surfaces of the mold to get a flat surface. Five hundred grams of scales were placed for 10 seconds on the top of the microscope glass slide to make bulk-fill composite resin evenly distributed throughout the mold. The specimens were polymerized with a light cure of Light Emitting Diode (LED) (Woodpecker LED B, Zhengzhou, China) for 20 seconds at a light intensity of 850 mW/cm². All specimens were roughened with sandpaper number 1200 for 5 seconds, and then the specimens were divided into three groups (surface roughness, microhardness, and color stability measurement). Each group was subdivided into three subgroups, each of which had 5 specimens, according to the type of polishing system as follows:

- Subgroup 1: The specimens were polished with a PoGo (Dentsply Sirona, Milford, USA) polishing system.
- Subgroup 2: The specimens were polished with an OptraPol (Ivoclar Vivadent, Schaan, Liechtenstein) polishing system.
- Subgroup 3: The specimens were polished with a OneGloss (Shofu Inc, Kyoto, Japan) polishing system.
Each group was polished with an intermittent technique for 15 seconds at a speed of 15.000 rpm. Furthermore, all specimens were immersed in distilled water and were incubated for 24 hours at 37°C.

**Surface Roughness**

Surface roughness was avowed by roughness average (Ra) in micrometers. Ra shows the arithmetic mean of the roughness measurement for a certain surface length. All specimens from the surface roughness group were measured using the Stylus Profilometer SE1700. The higher Ra value indicate the rougher bulk-fill composite resin surface. Data were analyzed by one-way ANOVA test and Least Significant Difference test.

**Microhardness**

Microhardness was avowed in units of Hardness Vickers Number (HVN). All specimens from the microhardness group were tested using the Vickers Microhardness Tester (HMV-M3). The hardness test was carried out on the surface with a load of 100 grams for 20 seconds. The average value of microhardness was obtained from three tests on each specimen. Data were analyzed by the Kruskal Wallis test and Mann-Whitney test.

**Color Stability**

The color stability test was performed before and after immersion with tea solution. Immersion was held for 7 days. Specimens were rinsed with water and dried with a tissue before testing. All specimens from the color stability group were tested using a spectrophotometer (Shimadzu Japan UV-2401-PC ISR-2200). The measurement of color change in bulk fill composite resin was calculated for its chromaticity value using the formula E (L*a*b*). Data were analyzed using the Kruskal Wallis test and Mann-Whitney test.

**RESULTS**

Table 1 and Figure 1 shows the surface roughness values of three subgroups from the surface roughness group. The specimens were polished using PoGo and exhibited the lowest average surface roughness value compared to Optapol and OneGloss (Table 1). One-way ANOVA analysis (Table 2) showed a significant difference between the three groups (p=0.006). The Least Significant Difference test (Table 3) showed that PoGo had a significant difference in the average surface roughness value compared to the OpraPol and OneGloss with a significance value of p<0.05.

![Figure 1. Mean and standard deviation value of surface roughness](image-url)
The microhardness values are shown in Table 1 and Figure 2. The PoGo had the highest average value of microhardness (56.08 HVN), followed by OneGloss (51.18 HVN) and OptraPol (43.56 HVN). Kruskal Wallis test (Table 4) denoted differences in microhardness between groups \((p=0.002)\). The Mann-Whitney test showed a significant difference \((p=0.009)\) between PoGo, the OptraPol and, OneGloss (Table 5).

Table 2. One-way ANOVA test

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
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<tr>
<td></td>
<td>7.963</td>
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<td>12</td>
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Table 3. Least Significant Difference test

<table>
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<th>Subgroup</th>
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<th>Sig.</th>
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<tbody>
<tr>
<td>Pogo</td>
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<td>.002*</td>
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<td>.033*</td>
<td></td>
</tr>
<tr>
<td>OneGloss</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>.148</td>
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<td>.033*</td>
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</tr>
<tr>
<td>OptraPol</td>
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<td></td>
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</tbody>
</table>

* Significant

Table 5. Mann-Whitney test

<table>
<thead>
<tr>
<th>Polishing System</th>
<th>OneGloss</th>
<th>OptraPol</th>
<th>Pogo</th>
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</thead>
<tbody>
<tr>
<td>OneGloss</td>
<td></td>
<td>.009*</td>
<td>.009*</td>
</tr>
<tr>
<td>OptraPol</td>
<td>.009*</td>
<td></td>
<td>.009*</td>
</tr>
<tr>
<td>Pogo</td>
<td>.009*</td>
<td>.009*</td>
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Table 6. Kruskal Wallis test

<table>
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<th>Test Statistics</th>
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<th>Day-7</th>
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<tbody>
<tr>
<td>Ch-square</td>
<td>0.215</td>
<td>7.220</td>
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<tr>
<td>df</td>
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<td>2</td>
</tr>
<tr>
<td>Asymp. Sig.</td>
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<td>0.027</td>
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Table 7. Mann-Whitney test

<table>
<thead>
<tr>
<th>Polishing System</th>
<th>OneGloss</th>
<th>Optrapol</th>
<th>PoGo</th>
</tr>
</thead>
<tbody>
<tr>
<td>OneGloss</td>
<td>.175</td>
<td>.175</td>
<td>.175</td>
</tr>
<tr>
<td>Optrapol</td>
<td>.175</td>
<td>-.009*</td>
<td></td>
</tr>
<tr>
<td>PoGo</td>
<td>.175</td>
<td>.009*</td>
<td></td>
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* Significant

DISCUSSION

Restoration surface quality is one of the important factors in long-lasting restoration using composite resin. The rough surface of composite resin restorations due to poor polishing causes staining, plaque adhesion, gum irritation and secondary caries. A rough surface also decreases mechanical properties and increases wear on restoration.

The polishing procedure can reduce the surface roughness of the composite resin. Roughness increases of more than 0.3 mm cause more stain absorption compared to surfaces with low roughness values. The rough surface of the restoration causes the staining material to adhere to the surface of composite resin easily. Surface roughness is also critical to composite resin restoration in the subgingival margin because related to periodontal disease development and hygiene is difficult.

Regarding the microhardness, the polishing procedure may increase the microhardness of composite resin. Microhardness is a composite resin property related to the resistance of composite resin to masticatory forces and affects the durability of the composite resin. Restoration surfaces with good hardness and resistance to wear are obtained by proper polishing procedures to remove the superficial layer composed of an organic matrix softer than the inner layer.

The polishing procedure also affects the discoloration of composite resin restoration. A high degree of smoothness and low porosity on the restoration surface reduces the attachment of the discoloring agent. Schmitt et al. stated that the low surface roughness value after polishing had the great color resistance.

The results showed that specimens polished using PoGo had the lowest surface roughness (p=0.006) and the highest microhardness (p=0.002) and color stability (p=0.027) compared to Optrapol and OneGloss. The abrasive particles’ hardness in a polishing system affected the effectiveness of the polishing system. Abrasive particles with higher hardness than composite resin filler possible to remove the soft matrix and filler appeared on the surface of the composite resin restoration, while the abrasive particles with a lower hardness than the composite resin filler only removed the soft matrix and left a filler on the surface. It can cause the surface of the composite resin restoration to become rough.

Lins et al. also stated that a polishing system with abrasive particles harder than composite resin fillers was more effective in removing the organic matrix layer and resulted in a harder surface.

The PoGo contained fine diamond powder of abrasive particles in its composition, while the Optrapol and OneGloss had aluminium oxide as the abrasive particle. Patel et al. stated that diamond powder of abrasive particles in PoGo had a Knoop Hardness of 7000 KHN, while aluminium oxide abrasive particles in OneGloss and Optrapol had a Knoop Hardness of 2100 KHN. Based on Moh’s hardness scale, the diamond particle has the highest hardness value (10), aluminium oxide has a hardness of 9, and composite resin has a hardness of 5-7. The fine diamond powder of abrasive particles in PoGo was more effective in removing the superficial layer of bulk-fill composite resin restorations containing organic matrix as they had a higher hardness than the aluminium oxide abrasive particles in Optrapol and OneGloss.
CONCLUSION
There were significant differences in surface roughness, microhardness, and color stability in bulk-fill composite resins polished with PoGo, OptraPol and One Gloss polishing system. Bulk fill composite resin polished using PoGo had a low surface roughness and discoloration change and had a higher microhardness value than bulk-fill composite resin polished using OptraPol and OneGloss.

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