ABSTRACT

Background: Composite resins are widely used in aesthetic restorative procedures with commendable success rates. Good finishing and polishing procedures give the restoration an improved esthetic appearance and longevity. The final outcome after finishing and polishing depends on various factors such as the material’s composition and the timing of finishing and polishing. This in vitro study assesses the surface smoothness of micro-filled hybrid composite (G-Aenial Anterior) with three commercially available polishing systems after immediate and delayed polishing.

Methods: A total of 120 identical disc-shaped specimens of a newly introduced micro-filled hybrid composite were subjected to three different polishing systems. The time to perform polishing was at two levels (immediately and after 7 days). The dependent variable was mean surface roughness (Ra, mm) (n = 20).

Results: Data were entered using the double-entry method into the STATA software version 13.1. Both Immediate and Delayed Roughness Indices of the three groups were tested by using the Shapiro-Wilks test. Analysis of variance was used to study the association between the mean of Immediate and Delayed Roughness Index among the three different polishing systems.

Conclusion: It was found that the newly introduced Soflex Spiral polishing system can give the best results when used for immediate polishing. However, Soflex Discs are best to be used in delayed polishing procedures that can be of significant value in certain restorative procedures.

Keywords: 3-Dimensional profilometry, novel micro-filled hybrid composite, polishing systems, surface roughness.

Introduction

Composite resins are widely used in aesthetic restorative procedures with commendable success rates. Over the years, there have been an array of materials for different patient needs. These materials are subjected to continuous research to enhance their longevity and aesthetic appearance. Good finishing and polishing procedures give the restoration an improved appearance and also prevent plaque retention, secondary caries and gingival inflammation. While finishing aims to remove the gross irregularities on the surface of the restoration, polishing gives the smoothness and final glossy appearance [1,2].

The final outcome after finishing and polishing depends on various factors such as the material’s composition, the timing of finishing and polishing, the heat generated, and the operator’s technique. The surface topography after the finishing and polishing procedures depends on the matrix and filler composition and proportions [3].

The heat generated during finishing and polishing can affect the bond between the restoration and tooth structure and the esthetic appearance of the restoration [4].
and the surface texture of the restoration. Hence, some researchers advocate delayed polishing to avoid these effects [4].

Because there are a variety of composites and polishing systems available, each of them should be carefully evaluated to detect which yields the best polishing outcome.

The surface roughness of the composite restorative material after polishing can be measured up by using qualitative methods such as the scanning electron microscope or quantitative methods such as profilometry [5,6].

**Aim**

This is an in vitro study that assesses the surface smoothness of micro-filled hybrid composite (G-Aenial Anterior, Shade A3, GC Corporation, Tokyo, Japan), with three commercially available polishing systems after immediate and delayed polishing.

**Material and Methods**

In this in vitro study, three different polishing systems were used on micro-filled hybrid composite specimens. The polishing was performed at two levels (immediately and after 7 days). The dependent variable was mean surface roughness (Ra, mm) (n = 20). The surfaces of the specimens were analyzed using a Profilometer (Bruker Contour GT, MA).

A total of 120 identical disc-shaped specimens (diameter = 10 mm, height = 2 mm) of a newly introduced micro-filled hybrid composite (G-Aenial Anterior) were prepared using custom made standardized mold as single increment using composite filling instrument. A polyester strip and a glass slide were positioned on the specimen using composite filling instrument. A mark was made on the outer edge of each specimen to standardize the direction of the rotating device application. Half of the specimens of each group were selected randomly and received polishing immediately after preparation. The other half were stored in a dark container on gauze soaked in distilled water at 37°C for 7 days. The following polishing procedures were applied.

Group I (n = 40): Polishing using Polishing Strips (Polydentia, Switzerland) in which double-sided adhesive was used to mount the strip to the glass slab. The polishing was done uniformly at 60 strokes/specimen. Group II (n = 40): Polishing using Soflex Discs (3M ESPE, St. Paul, MN), which is the sequential application of medium, fine, and superfine grain discs mounted on the handpiece. Each disc was applied to the specimen for 10 seconds under constant cooling with a water jet. Irrigation was performed between each application with compressed air/water for 5 seconds.

Group III (n = 40): Polishing using Soflex Spiral wheels (3M ESPE, St. Paul, MN), which is the sequential application of the pre-polishing wheel (beige) and diamond polishing spiral (pink) mounted on the handpiece. The specimens were mounted on a customized jig to standardize the load and force of the polishing technique.

After finishing and polishing, the specimens were washed for 10 seconds with compressed air/water and cleaned of debris. They were then placed in an ultrasonic bath in distilled water for 15 minutes to cleanse and remove all the particles from the surface of the specimens. After that, they were dried with paper towels and stored dry.

The specimens were mounted in the Profilometer (Bruker Contour GT, MA). The surfaces were scanned using a 5× objective, and the measurement area was 1 × 1 mm by vertical scanning interferometry. The measurement area was scanned five times and the average of the five scans was taken as the surface roughness value.

The surface roughness index (Ra”) between each measurement was calculated, and statistical analysis was performed using analysis of variance (ANOVA).

This study was approved by the dental ethics committee of Qassim University on 21/01/2020, with the approval number ST/6066/2019.

**Results**

**Statistical analysis**

The data were entered into the STATA software version 13.1 (Stata Corp, College Station, TX) using the double-entry method. There was no missing data. Both Immediate and Delayed Roughness Indices of the three groups “Polishing Strips, Soflex Discs, and Soflex Spiral wheels” were tested for normality assumption using the Shapiro-Wilks test and they were declared to be normally distributed as shown in Table 1. One way ANOVA was used to study the association between the mean of Immediate and Delayed Roughness Index among the three different Polishing Systems “Polishing Strips, Soflex Discs, and Soflex Spiral wheels.” To study the correlation between the Immediate and Delayed Roughness Index among the three groups of polishing,

<table>
<thead>
<tr>
<th>Polishing system</th>
<th>Shapiro-Wilk W test for normal data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
</tr>
<tr>
<td>Polishing Strips</td>
<td>20</td>
</tr>
<tr>
<td>Soflex Discs</td>
<td>20</td>
</tr>
<tr>
<td>Soflex Spiral wheels</td>
<td>20</td>
</tr>
</tbody>
</table>
Surface roughness of micro-filled hybrid composite and conventional polishing systems

**Table 2. Association between Immediate Surface Roughness Index and different polishing systems (n = 20/group).**

<table>
<thead>
<tr>
<th>Polishing</th>
<th>Surface Roughness Index</th>
<th>Mean</th>
<th>SD</th>
<th><em>p value</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Polishing Strips</td>
<td>4.80 ± 1.47</td>
<td></td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Soflex Discs</td>
<td>3.89 ± 1.11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soflex Spiral wheels</td>
<td>1.83 ± 0.61</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*F test - *p* value = 0.000 - Comparison of groups using Bonferroni correction: significant association between all groups of kits (*p* < 0.05).

**Table 3. Association between delayed surface roughness and different polishing systems (n = 20/group).**

<table>
<thead>
<tr>
<th>Polishing</th>
<th>Surface Roughness Index</th>
<th>Mean</th>
<th>SD</th>
<th><em>p</em> value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polishing Strips</td>
<td>6.08 ± 1.18</td>
<td></td>
<td></td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Soflex Discs</td>
<td>4.86 ± 0.97</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soflex Spiral wheels</td>
<td>5.13 ± 1.54</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*F test - *p* value = 0.008 - Comparison of groups using Bonferroni correction, shows significant association between Polishing Strips and Soflex Discs (*p* < 0.05).

**Table 4. Correlation between Immediate and Delayed Surface Roughness Index among different polishing systems (n = 20/group).**

<table>
<thead>
<tr>
<th>Polishing kit</th>
<th>r**</th>
<th><em>p</em> value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polishing Strips</td>
<td>0.35</td>
<td>0.13</td>
</tr>
<tr>
<td>Soflex Discs</td>
<td>-0.41</td>
<td>0.07</td>
</tr>
<tr>
<td>Soflex Spiral wheels</td>
<td>-0.04</td>
<td>0.85</td>
</tr>
</tbody>
</table>

**Pearson Correlation coefficient.**

* *p* value > 0.05.

we used the Pearson Correlation Coefficient. The Simple Linear Regression model was used to identify the predictor of immediate and delayed surface roughness among the study participants (*p*-value for the entrance of independent covariates was set at 0.5).

In general, a *p*-value of less than 0.05, two-tail probability was considered to be statistically significant with a 95% confidence interval.

Table 2 shows the association between the immediate surface roughness index and the polishing systems. Polishing with Polishing Strips (4.80 ± 1.47) had the highest Ra index, while Soflex Spiral wheels (1.83 ± 0.61) had the lowest Ra (*p* < 0.001).

Table 3 illustrates the association between the delayed surface roughness index and polishing systems. Polishing Strips (6.08 ± 1.18) had the highest Ra index while polishing with Soflex Discs (4.86 ± 0.97) had the lowest index (*p* < 0.001) as also represented graphically in Figure 1.

Table 4 verifies the correlation between immediate and delayed surface roughness using three different polishing kits. With respect to Polishing Strips, a non-significant positive association between immediate and delayed roughness index was demonstrated as seen in Figure 2. On the other hand, a non-significant negative association was proved for the other two types of polishing (*p* > 0.05) as seen in Figures 3 and 4.

**Discussion**

The surface roughness of the composite resin restoration has a great impact on gingival health, and it is thus important to achieve a shiny smooth composite restoration. Surface texture also plays a major role in
Surface roughness of micro-filled hybrid composite and conventional polishing systems

**Figure 2.** Correlation between Immediate and Delayed Roughness Index in Polishing Strips.

**Figure 3.** Correlation between Immediate and Delayed Roughness Index in Soflex Spiral wheels.
Surface roughness of micro-filled hybrid composite and conventional polishing systems

The finishing and polishing were done using different materials. Soflex Discs have been one of the most commonly used polishing materials over the years. However, new materials are introduced into the market every year and so this research, one of the first of this kind, compared the effect of Interproximal Polishing Strips, Soflex Discs, and Soflex Spiral wheels on composite surface roughness. The results of this research showed that there is a significant difference in the surface roughness between Polishing Strips, Soflex Discs, and Soflex Spiral wheels.

Immediate surface roughness was noticed to be significantly low in Soflex Spiral wheels when compared to both Polishing Strips and Soflex Discs. This was found similar to the results of Abzal et al. [5] where Soflex Spiral gave the least surface roughness when compared to other systems that were used in the study.

On the other hand, as detected in the results of this research, polishing with Soflex Discs has the lowest delayed surface roughness contrary to the results of Rai and Gupta [10] when compared with the other systems used in the study. The type of composite used could be the reason for such results since composite surface roughness is affected by the size, amount, and hardness of the filler particles [11,12].

G-ænial Anterior used in this study is a light-cured radiopaque micro-filled hybrid composite restorative with a combination of two types of pre-polymerized fillers containing silica, strontium, and lanthanoid particles. It offers clinically useful radio-opacity and maintains perfect aesthetics.

In the present research, surface roughness was far less in the immediate polishing systems in all the used systems, which is similar to the results of Lins et al. [13]. However, the results of Venturini et al. [14] showed that there was no significant difference between immediate and delayed surface roughness. We can explain that this dissimilarity is due to the time difference and the advancement in the polishing systems.

An additional benefit of this research is that Interproximal Polishing Strips and Soflex Spiral wheels were used. Soflex Spiral wheels have a significant advantage in polishing the hard-to-reach areas in the posterior teeth and they are effective from any angle. Hence, the results of this research can be extrapolated to such specific clinical situations.

We have to consider that we had tested only one type of composite resin in our research. The results of any other type of composite may vary, especially since surface roughness is material dependent [15].

**Conclusion**

It is seen that the newly introduced Soflex Spiral polishing system can give the best results when used for immediate
polishing, while Soflex Discs are best to be used in delayed polishing procedures, which can be of significance in certain restorative procedures. However, further research must be done on other types of composite resins taking into consideration factors such as the time involved in polishing and the pressure applied during the technique.

List of Abbreviations
ANOVA Analysis of variance
N Sample size
P Value of significance
Ra Mean surface roughness
W Shapiro-Wilk
Z Standardized test

Conflict of interest
The authors have no conflict of interest to declare.

Funding
No funding was received.

Consent to participate
Written informed consent was obtained from all the participants in this study.

Ethical approval
This study was approved by the Dental Ethical Committee of Dental Research Center, College of Dentistry, Qassim University, Kingdom Saudi Arabia, with reference number (ST/6066/2019), on 21/01/2020.

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