Comparative Evaluation of Surface Roughness of a Novel Micro-filled Hybrid Composite with Conventional and Contemporary Polishing Systems using 3 - Dimensional Profilometry.

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Abstract: Introduction: Composite resins are widely used in aesthetic restorative procedures with commendable success rates. Good finishing and polishing procedures give the restoration an improved esthetics appearance and longevity. The final outcome after finishing and polishing depends on various factors like material composition, timing of finishing and polishing. AIM: This is 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. Material And Methods: A total of 120 identical disc shaped specimens of a newly introduced micro filled hybrid composite is subjected to three different polishing systems. The time to perform the polishing was at 2 levels (immediately and after 7 days). The dependent variable was mean surface roughness (Ra, μm) (n=20). Results: The data was entered using double entry method into STATA software version 13.1. Both Immediate and Delayed Roughness Indices of the three groups were tested by using Shapiro-Wilks test. analysis of variance “ANOVA” was used to study the association between mean Immediate and Delayed Roughness Index among different three Polishing Systems. 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.

Keywords: Comparative; Evaluation; Surface; Roughness; Novel Micro-filled Hybrid Composite; Conventional; Contemporary; Polishing; System; Dimensional Profilometry

Introduction: Composite resins are widely used in aesthetic restorative procedures with commendable success rates. Over the years, there has been an array of materials for different patient needs. They are also one of the varied materials subjected to increasing research to enhance their longevity and aesthetic appearance. Good finishing and polishing procedures gives the restoration an improved appearance and also prevents 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 like material composition, timing of finishing and polishing, heat generated and operator technique. The surface topography after finishing and polishing procedures depends on the matrix and filler composition and proportions.3

Heat generated during finishing and polishing can affect the bond between the restoration and tooth structure and the surface texture of the restoration. Hence some researchers advocate delayed polishing to avoid these effects.4

Because of variety of composites and polishing systems available, they should be evaluated to which polishing systems yields the best polishing outcome.

The surface roughness of the composite restorative material after polishing can be measured up by qualitative methods such as, Scanning Electron Microscope or quantitative method, such as Profilometry. 5,6.

Aim: This is in vitro study 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 & methods: In this IN - VITRO study three different polishing systems were used on microfilled hybrid composite specimens. The time to perform the
polishing was at 2 levels (immediately and after 7 days). The dependent variable was mean surface roughness (Ra, \( \mu m \)) (\( n=20 \)). The surfaces of specimens were analyzed using a Profilometer (Bruker Contour GT, Massachusetts, USA).

A total of 120 identical disc shaped specimens (diameter=10mm, height=2mm) 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 strip followed by light-curing (40 seconds, 800 mW/cm\(^2\)) using a LED light-curing unit (Bluephase, Ivoclar Vivadent) positioned in direct contact with the polyester strip. A Radiometer (Ivoclar Vivadent) was used to check the intensity of light periodically. A marking was made on the outer edge of each specimen to standardize the direction of rotating device application.

Half of the specimens of each group randomly divided received polishing immediately after preparation. The other half was stored in 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. (\( n=40 \))

Group II (\( n=40 \)): Polishing using Soflex discs (3M ESPE, St. Paul, USA). It is the sequential application of medium, fine, and superfine grain discs, mounted on the hand piece. 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, USA). It is the sequential application of pre-polishing wheel (beige) and diamond polishing spiral (pink) mounted on the handpiece. The specimens were mounted on a customized gig to standardize the load and force of polishing technique. (\( n=40 \))

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 totally cleanse and remove the particles from the surface of the specimens, dried with paper towels, and stored dry.

The specimens were mounted in the Profilometer (Bruker Contour GT, Massachusetts, USA). The surfaces were scanned using a 5x objective, the measurement area being 1mm x 1mm 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. Statistical analysis was made using analysis of variance (ANOVA).

**Results:**

**Statistical Analysis:**

<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>

Table 1: Association between Immediate Surface Roughness Index and Different Polishing Systems (\( n=20 / \) group)

<table>
<thead>
<tr>
<th>Polishing</th>
<th>Surface Roughness Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Polishing Strips</td>
<td>4.80</td>
</tr>
<tr>
<td>Soflex Discs</td>
<td>3.89</td>
</tr>
<tr>
<td>Soflex Spiral wheels</td>
<td>1.83</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).

The data was entered using double entry method into STATA software version 13.1 (Stata Corp, College Station, Texas USA). There was no missing data. Both Immediate and Delayed Roughness Indices of the three groups “Polishing Strips - Soflex Discs - Soflex Spiral wheels” were tested for normality assumption using Shapiro-Wilks test and they were declared as normally distributed. One way analysis of variance “ANOVA” was used to study the association between mean Immediate and Delayed Roughness Index among different three Polishing Systems “Polishing Strips - Soflex Discs - Soflex Spiral wheels.”
To study the correlation between Immediate and Delayed Roughness Index among three groups of polishing, we used Pearson Correlation Coefficient. 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; $P$-value of less than 0.05, two-tail probability was considered to be statistically significant with a 95% confidence interval.

Table 1 shows the association between immediate surface roughness index and polishing systems. Polishing with polishing strips (4.80±1.47) has significantly the highest mean surface roughness index, while Soflex spiral wheels (1.83 ± 0.61) had the lowest mean surface roughness index ($p < 0.001$).

Table 2 illustrates the association between delayed surface roughness index and polishing systems. Polishing strips (6.08 ±1.18) had significantly the highest mean surface roughness index, while polishing with Soflex discs (4.86 ±0.97) had the lowest mean surface roughness index ($p < 0.001$).

![Figure 1: The Distribution of Mean Immediate and Delayed Surface Roughness Index According to Different Polishing Systems](image)

Table 3: Correlation between Immediate and Delayed Surface Roughness Index among Different Polishing System (n=20 / group)

<table>
<thead>
<tr>
<th>Polishing Kit</th>
<th>$r^*$</th>
<th>$p^*$</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
Table 3 verifies the correlation between immediate and delayed surface roughness using three different polishing kits. Considering polishing strips, a non-significant positive association between immediate and delayed roughness index was demonstrated. On the other hand, a non-significant negative association was proved for the other two types of polishing. (p>0.05)

Figure 2: Correlation between Immediate and Delayed Roughness Index with Polishing Strips

Figure 3: Correlation between Immediate and Delayed Roughness Index in Soflex Spiral Wheels
Discussion:

The surface roughness of the composite resin restoration has a great impact on the gingival health. It is important to achieve a shiny smooth composite restoration. Surface texture also plays a major role in the aesthetics of the final restoration. A surface roughness of 0.50 μm can be detected by patients with their tongues.7,8,9

Finishing and polishing is done using different materials. Soflex discs are one of the most commonly used polishing material over the years. New materials are introduced into the market every year. This is one of the first research comparing the effect of Interproximal polishing strips, Soflex-discs and Soflex-spiral wheels on composite surface roughness. The results of this research has 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 where Soflex spiral gave the least surface roughness when compared other systems that were used in the study.10

On the other hand, as it appears in the results of this research, polishing with Soflex-discs has the lowest delayed surface roughness contrary to the result of (Rai and Gupta 2013) when compared with the other systems used in the study.11 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 filler particles (Chung 1994)12,13

G-anial Anterior used in this study is a light-cured radiopaque microfilled hybrid composite restorative with a combination of 2 types of pre-polymerized fillers containing silica, strontium and lanthanoid particles offering clinical useful radiopacity while maintaining perfect aesthetics. In the present research, surface roughness was far less in immediate polishing systems in all the used systems, which is similar to the results of (Lins et al 2016)14. However, in contrast with Venturini et al where there was no significant difference between immediate and delayed surface roughness.15 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 of hard to reach areas in posterior teeth and 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 have only tested one type of composite resin in our research. The results of any other type of composite may vary, especially that surface roughness is material dependent.16
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 and take into consideration factors like the time involved in polishing and pressure applied during the technique.

References: