The Effect of Different Polishing Protocols on the Surface Topography and Smoothness of Different Indirect Restorative Materials

<u>**STUDY**</u>

Lucie Zi Xuan Yin DMD

Julian Conejo DDS, MSc

Markus B Blatz DMD, PhD

University of Pennsylvania

School of Dental Medicine

240 S. 40th Street

Philadelphia, PA 19104

Abstract:

The objective of this pilot study was to evaluate the effect of different polishing protocols on Luxatemp, a bisacryl temporization material, LuxaCrown, a new bisacryl semi-permanent restorative material,Luxacam composite block, a highly networked composite matrix with 70% embedded silicate glass filling substances, and Telio CAD, a polymethyl methacrylate (PMMA) CAD/CAM block.

Aim of the study:

-To study the polishability of materials that need to be hand polished

-To determine if CAD/CAM materials are much smoother than an injected bisacryl material

-To assess if there a difference between the 2 step, 3 step and unpolished surface for each of the materials, and which polishing method provides superior results.

Hypothesis:

There is a difference in surface topography and smoothness of restorative materials Luxatemp, LuxaCrown, Telio CAD block, and Luxacam block using different polishing protocols.

Materials and methods:

For this pilot study, a total of 72 specimens were prepared by compressing Luxatemp and LuxaCrown in a 10 mm x 2 mm ring, as well as sectioning Telio CAD and Luxacam blocks in 10 mm x 2 mm specimens.

The samples were assigned a number and stored for 45 mins in a 37-degree Celsius water bath. Following the water bath, each specimen was finished with sandpaper to simulate a clinical finishing procedure.

Sample Preparation:

The samples were then randomly divided into the following 12 groups (n=6, total of 72 specimens):

1) Control group LT (Luxatemp): unpolished.

2) Brasseler (3 step) polishing protocol LT: GRAY POLISHER (Brasseler USA # PFL26FHP), GOAT-HAIR CHAMOIS WHITE STIFF BRUSH (Brasseler USA # 10050022HP), FELT CLOTH WHEEL BUFF (Brasseler USA # 16222HP) with COMPOSITE PASTE (Brasseler USA # ETCP8M).

3) Brasseler (3 step) polishing protocol LT: GRAY POLISHER (Brasseler USA # PFL26FHP), GOAT-HAIR CHAMOIS WHITE STIFF BRUSH (Brasseler USA # 10050022HP).

4) Control group LCr (LuxaCrown): unpolished.

5) Brasseler (3 step) polishing protocol LCr: GRAY POLISHER (Brasseler USA # PFL26FHP), GOAT-HAIR CHAMOIS WHITE STIFF BRUSH (Brasseler USA # 10050022HP), FELT CLOTH WHEEL BUFF (Brasseler USA # 16222HP) with COMPOSITE PASTE (Brasseler USA # ETCP8M).

6) Brasseler (2 step) polishing protocol LCr: GRAY POLISHER (Brasseler USA # PFL26FHP), GOAT-HAIR CHAMOIS WHITE STIFF BRUSH (Brasseler USA # 10050022HP).

7) Control group LC (Luxacam block): unpolished.

8) Brasseler (3 step) polishing protocol LC: GRAY POLISHER (Brasseler USA # PFL26FHP), GOAT-HAIR CHAMOIS WHITE STIFF BRUSH (Brasseler USA # 10050022HP), FELT CLOTH WHEEL BUFF (Brasseler USA # 16222HP) with COMPOSITE PASTE (Brasseler USA # ETCP8M).

9) Brasseler (2 step) polishing protocol LC: GRAY POLISHER (Brasseler USA # PFL26FHP), GOAT-HAIR CHAMOIS WHITE STIFF BRUSH (Brasseler USA # 10050022HP).

10) Control group T (Telio CAD): unpolished.

11) Brasseler (3 step) polishing protocol T: GRAY POLISHER (Brasseler USA # PFL26FHP), GOAT-HAIR CHAMOIS WHITE STIFF BRUSH (Brasseler USA # 10050022HP), FELT CLOTH WHEEL BUFF (Brasseler USA # 16222HP) with COMPOSITE PASTE (Brasseler USA # ETCP8M).

12) Brasseler (2 step) polishing protocol T: GRAY POLISHER (Brasseler USA # PFL26FHP), GOAT-HAIR CHAMOIS WHITE STIFF BRUSH (Brasseler USA # 10050022HP).

The specimens were polished by a single investigator at 10,000 RPM for 2 minutes each. While being polished, the samples were tracked in the same direction.

Storage and testing methods:

After polishing, each specimen was rinsed under distilled water and placed in an ultrasonic bath for 10 minutes. Surface roughness in the form of surface finish (Ra) was recorded on 3 random sites of each sample using the Zygo Optical Profilometer.

The surface of the specimens was observed under a scanning electron microscope to visualize surface roughness. The data was analyzed with two-way analysis of variance (Tukey's test) ($P < 0.05$).

Results and discussion:

For this pilot study, the Zygo optical profilometer was used to obtain surface measurements for 3 data points per polished surface. For each data point, Ra, rms, and PV values were obtained. In addition, graphical representations of the 3D model, surface profile, intensity map, oblique plot, slope x map, slope y map, and slope mag map were obtained for each data point. The slope maps allow visualization of surface detail at a magnified level. The numerical data were then computed in an Excel sheet and in a statistical analysis software.

The Ra value was used for data analysis, as described in the study protocol. It represents the arithmetic average of surface heights measured across a surface and is a more commonly used measurement for surface roughness. A smaller Ra value indicates a smoother surface with less surface roughness.

Based on a preliminary assessment of the pilot study data, the material with the greatest Ra value is the 2 step Luxatemp, which exhibits the roughest surface (Average Ra = 0.124277778 μm). Materials with the lowest Ra value are the 3 step Luxatemp showing the smoothest surface (Average Ra = 0.06952941 μm), followed the 3 step LuxaCrown (0.074222222 μm).

The order of materials based on surface smoothness after polishing is as follows:

1. 3 step Luxatemp (Average Ra = 0.0695μm)
2. 3 step LuxaCrown (Average Ra = 0.0742 μm)
3. 3 step Luxacam (Average Ra = 0.0832 μm)
4. 2 step LuxaCrown (Average Ra = 0.0952 μm)
5. 2 step Teliocad (Average Ra = 0.1014 μm)
6. 3 step Teliocad (Average Ra = 0.1124 μm)
7. 2 step Luxacam (Average Ra = 0.1138 μm)
8. 2 step Luxatemp (Average Ra = 0.1243 μm)

Table 3. Optimal polishing method for each material

Material	Polishing method with best polishing result
Luxatemp	3 step (Average Ra = 0.0695μm)
Luxacam	3 step (Average Ra = 0.0832 μm)
Teliocad	2 step (Average Ra = 0.1014 μm)
LuxaCrown	3 step (Average Ra = 0.0742 μm)

The 3-step polishing method consists of the following steps:

1) Gray polisher (Brasseler USA # PFL26FHP)
2) Goat hair chamois white stiff brush (Brasseler USA # 10050022HP)
3) Felt cloth wheel buff (Brasseler USA # 16222HP) and composite paste (Brasseler USA # ETCP8M)

The 2-step polishing method consists of the following steps:

1) Gray polisher (Brasseler USA # PFL26FHP)
2) Goat hair chamois white stiff brush (Brasseler USA # 10050022HP)

According to our pilot study, it can be concluded that in general, the 3-step polishing method results in lower surface Ra values, except for Telio CAD, which shows lower surface Ra values with 2 step polishing.

Table 4. Material showing the smoothest surface according to polishing method

Polishing method	Material with best polishing outcome
2 step polishing	LuxaCrown (Average Ra = 0.0952 μm)
3 step polishing	Luxatemp (Average Ra = 0.0695 μm), followed by LuxaCrown (Average Ra = 0.0742 μm)

In terms of statistical analysis, a Two-Way Analysis of Variance was performed.

The difference in the mean values among the different materials is not great enough to exclude the possibility that the difference is just due to random sampling variability after allowing for the effects of differences in polishing methods. There is no statistically significant difference (P = 0.654) noted. Therefore, there is no significant difference among the four types of materials (Luxatemp, Luxacam, LuxaCrown and Teliocad) in terms of surface roughness after 2-step and 3-step polishing.

The difference in the mean values among the different polishing methods is greater than would be expected by chance after allowing for effects of differences in material used. A statistically significant difference (P = 0.048) was detected. Thus, the 3-step method is significantly better than the 2-step polishing protocol with regards to surface roughness measurements.

The effect of different materials used does not depend on the polishing method. There is not a statistically significant interaction between materials and polishing method. (P = 0.198). A power analysis was performed for this pilot study and the results are as follows:
Power of performed test with alpha = 0.0500: for material: 0.0500
Power of performed test with alpha = 0.0500: for polishing method : 0.387
Power of performed test with alpha = 0.0500: for material x polishing method : 0.169
The sample size will need to be increased for the pilot, and a realistic sample size recommended would be 40 per group.

The least square means for each material is listed below:

Group Mean SEM
Luxatemp: 0.0969 0.0111
Luxacam: 0.0985 0.0103
Teliocad: 0.107 0.0101
LuxaCrown: 0.0847 0.0103

The least square means for polishing methods is listed as follows:

Group Mean SEM
2-step: 0.109 0.00932
3-step: 0.0825 0.00928

The least square means for material x polishing method are as follows:

Group Mean SEM
Luxatemp x 2 step: 0.128 0.0160
Luxatemp x 3 step: 0.0657 0.0155
Luxacam x 2 step: 0.114 0.0146
Luxacam x 3 step: 0.0832 0.0146
Teliocad x 2 step: 0.101 0.0142
Teliocad x 3 step: 0.112 0.0142
LuxaCrown x 2 step: 0.0952 0.0146
LuxaCrown x 3 step: 0.0742 0.0146

All Pairwise Multiple Comparison Procedures (Holm-Sidak method) with an overall significance level of 0.05, and polishing method as factor for comparisons.

Conclusion:

In conclusion, this pilot study showed that the material with the greatest Ra value is the 2 step Luxatemp, which exhibits the roughest surface (Average Ra = 0.124277778 μm). Materials with the lowest Ra value are the 3 step Luxatemp showing the smoothest surface (Average Ra = 0.06952941 μm), followed the 3 step LuxaCrown (0.074222222 μm). In general, the 3-step polishing method results in lower surface Ra values, except for Teliocad, which shows lower surface Ra values with 2 step polishing.

There is no statistically significant difference among the four types of materials (Luxatemp, Luxacam, LuxaCrown and Teliocad) in terms of surface roughness after 2-step and 3-step polishing. Regarding the polishing method, the 3-step method is significantly better than the 2-step polishing protocol.