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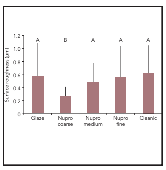
Effect of Prophylactic Polishing Pastes on Roughness and Translucency of Lithium Disilicate Ceramic



Carlo Monaco, DDS, MSc, PhD[1]
Antonio Arena, DDS[2]
Mutlu Özcan, DDS, Dr Med Dent, PhD[3]

This study evaluated the effect of prophylactic polishing pastes on the roughness and translucency of lithium disilicate ceramic. Sixty specimens were obtained from e.max CAD blocks. After ground finishing, each specimen was glazed and randomly divided into one of five groups, including one control group. They were then polished with one of four types of prophylactic paste. Group A: Nupro coarse, group B: Nupro medium, group C: Nupro fine, and group D: Cleanic. Specimens were polished with these pastes for 2 minutes with a prophy cup mounted on the handpiece under a constant load of 400 gr at 3,000 rpm. After polishing, the specimens were cleaned ultrasonically in distilled water and dried. The surface roughness (Ra, µm) was then measured using a surface profilometer. The translucency analysis was carried out on the glazed (control group) and polished specimens using a dental spectrophotometer. For each specimen, measurements were made once with a white and once with a black background. Group A showed significantly less surface roughness compared with the control group and groups B, C, and D. The control group showed significantly higher translucency compared with the other groups (P < .05). Despite the good abrasion resistance of e.max CAD lithium disilicate ceramic, prophylactic pastes produced a reduction in translucency. Surface roughness varied depending on the paste used. Polishing procedures should be carried out with caution to not compromise the esthetics achieved with prosthetic restorations. (Int J Periodontics Restorative Dent 2014;34:e26–e29. doi: 10.11607/prd.1155)

[1]Assistant Professor, Division of Prosthodontics and Maxillofacial Rehabilitation, Department of Biomedical and NeuroMotor Sciences, University of Bologna, Bologna, Italy.
[2]Lecturer, Division of Prosthodontics and Maxillofacial Rehabilitation, Department of Biomedical and NeuroMotor Sciences, University of Bologna, Bologna, Italy.
[3]Professor and Head of Dental Materials Unit, University of Zürich, Center for Dental and Oral Medicine, Clinic for Fixed and Removable Prosthodontics and Dental Materials Science, Zürich, Switzerland.

Correspondence to: Dr Carlo Monaco, Division of Prosthodontics and Maxillofacial Rehabilitation, Department of Biomedical and NeuroMotor Sciences, University of Bologna, ViaSan Vitale, 59 40125 Bologna, Italy; email: carlo.monaco2@unibo.it.

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The polishing of dental restorations is required to remove biofilm and extrinsic stains and to achieve a smooth, glossy, mirror-like surface. For this purpose, prophylactic pastes of coarse to fine particles are generally used.[1] Polishing agents are typically based on silicon dioxide, pumice, calcium carbonate, and stannic oxide.[1] Previous studies reported increased surface roughness on composite resins compared with baseline after polishing with prophylactic pastes, regardless of particle size.[2–4] However, information regarding the effect of prophylactic pastes on ceramics is limited in the dental literature.[5–7]

Ceramics are used for their superior translucency, which allows for mimicking the optical properties of enamel. Translucency is the ratio of light reflectance of an object on a black background compared with the reflectance of the same object on a white background.

The extended use of ceramic restorations may necessitate professional hygiene protocols that may affect surface roughness and, thereby, the translucency. In fact, recent all-ceramics, in their fully

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crystallized state, show excellent physical properties and may not suffer from degradation by polishing processes.[8]

The objectives of this study were to evaluate the effect of prophylactic polishing pastes of different types on the roughness and translucency of a new all-ceramic. The tested null hypotheses was that prophylactic polishing pastes would not affect the surface roughness or translucency of the ceramic to be tested.

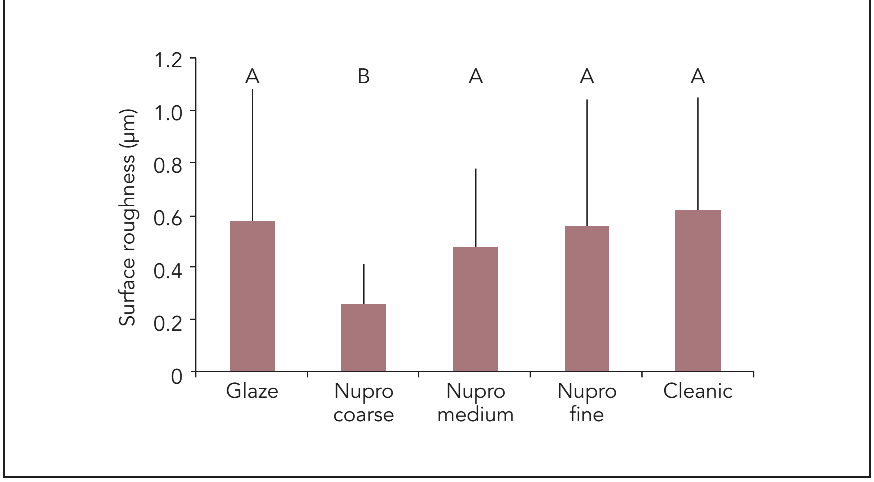

Fig 1 *Mean surface roughness and SDs of ceramics after glazing and polishing with prophylactic pastes. The same capital letters indicate no significant difference.*

Method and materials

Specimen preparation

Sixty flat specimens (15 × 13 × 2 mm) were obtained from partially crystallized ceramic blocks (IPS e.max CAD, Ivoclar Vivadent) using a diamond blade (diameter: 100 mm, thickness: 0.33 mm, grit: 150 µm) (Norton, Saint-Gobain Abrasives) under wet conditions. The specimens were further ground finished with silicone carbide papers (Struers) in a sequence of 500, 800, and 1,000 grit. They were then ultrasonically cleaned (Quantrex, L&R Ultrasonics) in distilled water for 10 minutes and dried. The ceramic specimens were crystallized and glazed (e.max CAD Glaze Spray, Ivoclar Vivadent) according to the manufacturer's instructions. After shaking the bottle for 20 seconds, glaze spray was twice applied 10 cm away from the surface under controlled conditions.

Surface roughness

Surface roughness (Ra, µm), ie, the arithmetic mean value of the deviations of the real profile of the surface compared to the median line, was measured using a profilometer (Perthometer M4P).[9] The glazed specimens were randomly divided into five groups, one of which acted as the control group. The specimens in the other groups were polished with four types of prophylactic polishing pastes: Group A: Nupro coarse (74 to 177 µm) (Dentsply), group B: Nupro medium (74 to 105 µm), group C: Nupro fine (1 to 45 µm), and group D: Cleanic (45 µm) (Kerr). Specimens were polished with these pastes for 2 minutes with a prophy cup mounted on the handpiece under a constant load of 400 gr at 3,000 rpm. The residue of prophylactic paste was cleaned using a commercial liquid detergent. The specimens were dried and then placed in separate glass containers. The tracer was placed 2.5 mm away from the lateral sides and 3 mm away from the horizontal sides. It was set to run a length of 4.8 mm. After each reading, the tracer made the second measurement 1 mm away from the first measurement line. This allowed 10 parallel measurements from each specimen, yielding to a total of 120 measurements per group.

Translucency

Translucency measurements were made both from glazed and prophylactic paste–polished specimens using a dental spectrophotometer (Pikkio, MHT). The percentage of translucency was calculated by considering the degree of dispersion of

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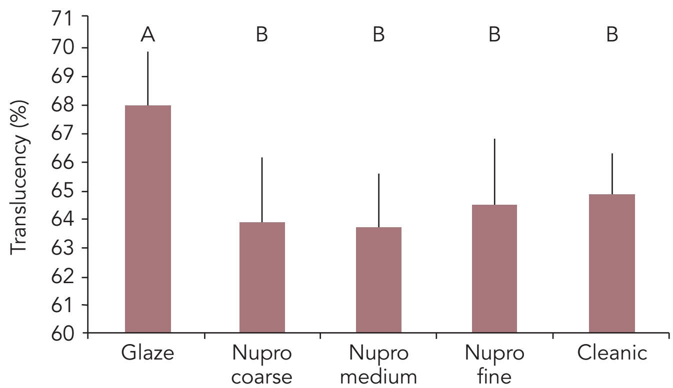

Fig 2 *Mean translucency and SDs of ceramics after glazing and polishing with prophylactic pastes. The same capital letters indicate no significant difference.*

light through the object being analyzed. The reading was performed by placing the sensor perpendicular to the specimen's surface. The measurements were made in the middle of the specimen from a reading area of 3-mm diameter. The spectrophotometer was calibrated after every 15 specimens. Translucency was measured from three readings of the same surface area on both white and black backgrounds.

Statistical analysis

Statistical analysis was performed using SPSS version 11.0 software (IBM). The data were analyzed using the Tukey-Kramer test. *P* values less than .05 were considered statistically significant in all tests.

Results

Group A (0.26 ± 0.15 µm) showed significantly less surface roughness compared with the control group (0.58 ± 0.5 µm) and groups B (0.48 ± 0.3 µm), C (0.56 ± 0.48 µm), and D (0.62 ± 0.43 µm) ($P < .05$) (Fig 1).

The control group showed significantly higher translucency (68%) compared with the other groups (group A: 64%, group B: 64%; group C: 65%; group D: 65%) ($P < .05$) (Fig 2).

Discussion

The results of this study showed a significant increase in the surface roughness of glazed ceramics, except for the group polished with Nupro coarse. Translucency of the ceramics, however, decreased significantly. Therefore, the null hypothesis could be partially accepted. Interestingly, the coarse prophylactic paste, with 74- to 177-µm particle sizes according to the manufacturer, showed significantly less surface roughness. Although the polishing procedures were performed under controlled conditions, some variations could be expected. In fact, roughening procedures could be influenced as a function of time and pressure. Tribological changes can vary depending on the changes in these parameters. The peaks of rough surfaces probably disappeared and leveled off after a certain period with this coarse paste. Therefore, it cannot be generalized that coarse particles always create rough surfaces. In this study, polishing was performed for only 2 minutes. Although it was not the purpose of this study to measure the thickness of the glaze layer, the glaze layer may have been removed to some extent after polishing for this duration of time. The removal of the outer glaze layer may have resulted in a subsurface glaze measurement that translated to a smoother surface measurement. This could also be the reason for the lower roughness values obtained with the use of Nupro coarse paste. The roughness results obtained with Nupro coarse were followed by Nupro medium but were not significantly different from the other groups with less coarse pastes. This also supports the assumption that some

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glaze layer was removed. However, subsurface glaze layer characterization needs further study where the thickness of the glaze layer from cross sections can be analyzed.

Longer or shorter durations of polishing may also change the results. In this study, the specimens were polished with the pastes using a prophy cup on the handpiece at 3,000 rpm. Although today's handpieces may work at up to 20,000 rpm, speedy rotating handpieces may lead to the sudden spread of slurry (prohylactic polishing paste) from the zone of interest. This consequently decreases the real polishing effect of the slurry as the prophy cup is then in contact with the ceramic or tooth surface alone, which is not sufficient to remove the biofilm or the extrinsic stain.

On the other hand, translucency decreased significantly after prophylactic cleaning compared with the glazed specimens, including after use of the coarse prophylactic paste. Loss of translucency due to glaze wear results in opacification of the restoration. Translucency depends on several factors, including the crystalline structure, thickness, and size of the grains; the number of defects; and the presence of porosity.[10]

Besides esthetic deteriorations, abrasion resistance of the glaze also has another important aspect to consider. An increase in roughness from 0.2 to 5.8 µm in glass-ceramic veneers could lead to a reduction in flexural strength from 103 to 65 MPa.[11] Increased roughness also results in increased plaque accumulation on ceramics[12] and increased wear of the antagonist enamel.[13,14] The results of this study need to be verified in clinical studies.

Conclusions

Despite the good abrasion resistance of e.max CAD lithium disilicate ceramic, prophylactic pastes produced a reduction in translucency compared with glazed specimens. Surface roughness of the ceramics varied depending on the paste used. Coarse prophylactic paste does not necessarily yield an increased surface roughness. As a result, polishing procedures for ceramics should be carried out with caution in order to not compromise the esthetics achieved with prosthetic restorations.

Acknowledgment

The authors reported no conflicts of interest related to this study.

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