The Effectiveness of Polishing Kits: Influence on Surface Roughness of Zirconia

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This study investigated the effectiveness of intraoral and technical polishing kits. Zirconia specimens were sintered, ground, and polished with 14 different two-step or three-step polishing kits. Surface roughness (R_a, R_z) after each treatment step was determined, and scanning electron micrographs were made. Except for one system, all polishing kits were effective in reducing the surface roughness of ground zirconia. Differences in surface roughness were high after the first polishing step but were reduced to R_a/R_z values similar to or lower than those of the sintered reference after the final polishing step. Achieving smooth surfaces depended on a sequential application of all polishing steps. *Int J Prosthodont 2015;28:149–151. doi: 10.11607/ijp.4153*

With monolithic zirconia restorations serving as an alternative to commonly veneered crowns or fixed partial dentures, the ideal surface finish of zirconia has been discussed.[1–4] Smooth surfaces are considered to be important for esthetics and the long-term success of the restoration. However, the high strength and hardness of zirconia may be a challenge for adjustment and polishing.

The hypothesis of this in vitro study was that different polishing kits are unequally effective in reducing surface roughness of zirconia.

Materials and Methods

Specimens (N = 75; 6 × 6 cm; thickness: 1.5 mm) were prepared from yttria-stabilized zirconia (Cercon HT, DeguDent), sintered (Cercon heat), and subjected to a sequence of clinically relevant surface treatments. Five specimens were left sintered to serve as a reference. All other specimens were ground with a diamond bur (837LF-FG014, 27 to 76 µm, Meisinger) using a dental turbine under standardized conditions (forward and reverse movement, 10 seconds, water cooling, 1 N). Afterward, the specimens were progressively polished (30 seconds per step, 2 N) with 14 different multistep polishing kits (five specimens per group; Table 1) by following the manufacturers' recommendations. The applied forces were determined before and controlled during polishing. The polishing direction was consistent with the grinding direction. Surface roughness values (R_a, R_z) after each treatment step were determined perpendicular to the grinding/polishing direction using a profilometric contact surface measurement device (Perthometer-SP6, Feinprüf-Perthen; five measurements per specimen; traversing length = 1.7 mm/0.25 mm, 2-µm diamond indenter). Mean values and SDs were calculated and analyzed with SPSS version 19.0 statistical software (SPSS) by means of one-way analysis of variance and post-hoc Bonferroni multiple-comparison test (α = .05). Scanning electron microscopy (SEM; low vacuum; Quanta FEG-400, FEI) was used for qualitative surface evaluation.

Results

Surface roughness R_a and R_z (Table 1) showed statistically significant (P < .05) differences between the groups.

Grinding of the sintered surfaces significantly increased R_a. All polishing kits significantly reduced this high roughness with the first polishing step. Roughness was further reduced with the following polishing steps; however, both steps for two-step systems and step 2 and 3 for three-step systems did not differ significantly (except for one two-step system). Comparing the different systems, mean R_a after step 1 ranged between 0.11 and 0.85 µm, showing significant

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Table 1 Surface Treatment of Zirconia with Different Polishing Kits: Mean (SD) Surface Roughness, R_a and R_z

Surface treatment	R_a (µm)			R_z (µm)		
Sintering (reference)		0.24 (0.04)			1.69 (0.04)	
Grinding		1.22 (0.18)			6.09 (0.83)	
Polishing	**Step 1**	**Step 2**	**Step 3**	**Step 1**	**Step 2**	**Step 3**
Intraoral 3-step polishing kits						
CeraGlaze (NTI-Kahla)	0.51 (0.18)	0.21 (0.06)*	**0.08 (0.03)***	2.24 (0.61)	1.11 (0.10)*	**0.65 (0.20)***
Zenostar (Wieland)	0.85 (0.14)	0.37 (0.06)*	**0.25 (0.06)***	5.60 (0.54)	2.82 (0.62)	**1.78 (0.34)**
OptraFine (Ivoclar Vivadent)	0.22 (0.09)*	0.17 (0.08)*	**0.18 (0.05)***	1.46 (0.34)*	1.04 (0.46)*	**1.07 (0.34)***
Komet Ceramic kit (Brasseler)	0.91 (0.16)	0.23 (0.05)*	**0.19 (0.04)***	4.28 (0.38)	1.83 (0.27)*	**1.68 (0.35)***
Intraoral 2-step polishing kits						
Komet zirconia kit (Brasseler)	0.34 (0.11)*	**0.26 (0.07)***	–	3.21 (0.61)	**1.77 (0.45)**	–
Bruxzir set (Axis)	0.31 (0.18)*	**0.15 (0.06)***	–	3.62 (0.48)	**0.92 (0.45)**	–
Diacera (EVE)	0.34 (0.11)*	**0.23 (0.05)***	–	1.66 (0.27)*	**1.32 (0.38)***	–
CeraMaster/CeraMaster Coarse (Shofu)	0.30 (0.10)*	**0.15 (0.05)***	–	1.13 (0.31)*	**0.99 (0.24)***	–
Zircovis (Kenda)	0.56 (0.13)	**0.23 (0.06)**	–	5.04 (0.25)	**1.25 (0.73)**	–
All Ceramic (Kenda)	0.73 (0.16)*	**0.65 (0.17)***	–	5.27 (0.17)	**3.47 (0.85)**	–
Technical 3-step polishing kits						
Zirconia polishers (Zirkonzahn)	0.61 (0.20)	0.12 (0.05)*	**0.11 (0.05)***	3.73 (0.38)	0.85 (0.23)*	**0.75 (0.21)***
Diaceram (Diaswiss)	0.23 (0.03)*	0.12 (0.03)*	**0.06 (0.02)***	1.66 (0.14)*	1.61 (0.10)*	**0.54 (0.04)**
Technical 2-step polishing kits						
Zirconia polishers (Meisinger)	0.11 (0.05)*	**0.06 (0.02)***	–	0.77 (0.18)*	**0.54 (0.11)***	–
Dia Blue O-Cera (Topdent, Kentzler-Kaschner)	0.11 (0.03)*	**0.08 (0.01)***	–	0.87 (0.27)*	**0.65 (0.31)***	–

Bold = final polishing; – = no step 3 available.
*No significant differences between the polishing steps within a system ($P > .05$).

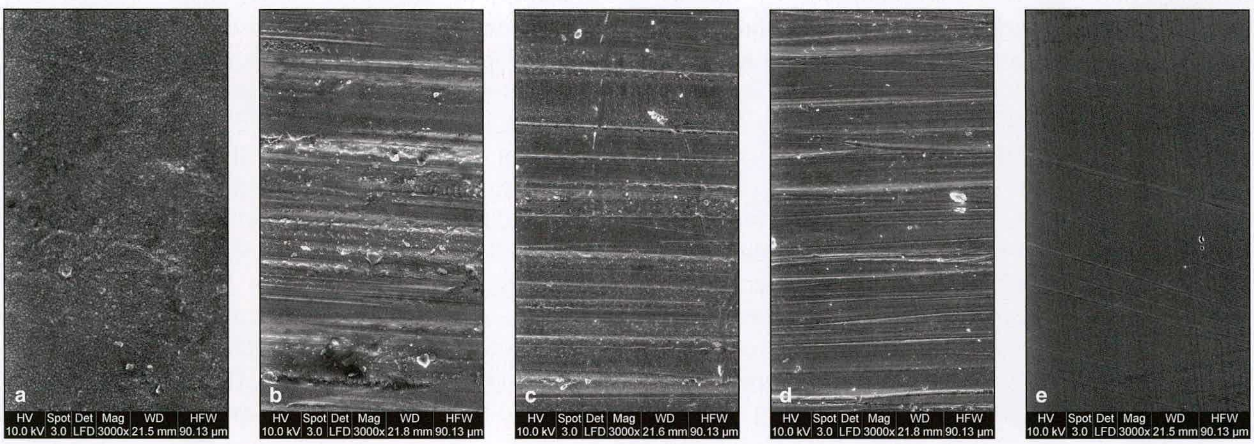

Fig 1 Scanning electron microscopy images (magnification: ×3,000) of zirconia after **(a)** sintering, **(b)** grinding, **(c)** polishing step 1, **(d)** step 2, and **(e)** step 3. Example from three-step intraoral polishing kit (CeraGlaze).

differences. After final polishing, the significantly lowest R_a (0.06 µm) was found for two technical kits and the significantly highest R_a (0.65 µm) for one intraoral two-step system. None of the other polishing kits differed significantly from one another or from the sintered references.

After a significant increase of R_z by grinding, the first polishing step significantly reduced roughness for most systems (exceptions: Zenostar, Wieland; All Ceramic, Kenda; and Zircovis, Kenda), varying widely between 0.77 and 5.60 µm. Similarly to R_a, R_z values were further reduced with the succeeding steps but showed a higher number of significant differences. After final polishing, the technical kits and one intraoral two-step kit (CeraGlaze) revealed the significantly lowest values. Except for one intraoral two-step system, final R_z was similar or even lower than for the sintered references.

SEM images (Fig 1) showed rough surfaces with deep grooves after grinding that were progressively smoothened by polishing.

Discussion

The hypothesis of unequal effectiveness of different polishing kits has to be widely rejected. Except for one system, the final surface roughness of all kinds of polishing systems was lower than 0.2 to 0.3 µm (R_a)/ 1.8 µm (R_z), which is similar to or even less than reported for glaze.[3,5] As differences in roughness were high after the first polishing but could be reduced to similar values after final polishing, a sequential application of all polishers in two- or three-step systems seems to be essential for an effective smoothening. Highly smooth zirconia surfaces gain importance with the application of full-contour zirconia restorations, as low-surface roughness was shown to cause even less antagonistic enamel wear than conventional veneering ceramics.[1,3] Good polishing performance of zirconia may be based on its homogenous and fine microstructure, which could be visualized in the SEM images. Damage caused by occlusal adjustment of contact points (eg, grinding grooves) might further serve as the origin of cracking or catastrophic failure.[2] Therefore, accurate polishing with appropriate polishing kits for zirconia seems to be important for clinical long-term success.

Conclusions

The majority of technical and intraoral sets were effective in reducing surface roughness of zirconia. Both two-step and three-step systems showed good results after passing all polishing steps and may be recommended for reglazing of ground surfaces.

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Literature Abstract

Factors affecting peri-implant bone loss: A post-five-year retrospective study

This article studied the factors that may influence peri-implant bone loss. A total of 148 patients with 585 implants rehabilitation over a follow-up period of 5 years were longitudinally studied. Radiographic bone loss around implant was studied. Various potential bone loss factors such as oral hygiene, implant size, and prosthesis design also were considered. The results showed the effect of the implant platform to the prosthesis horizontal component (> 3.3 mm and < 6 mm) has the largest influence on peri-implant bone loss. More bone loss was observed when the aforementioned distance was below 3.3 mm, while the distance larger than 6 mm has no effect on the level of bone loss. However, this paper did not clearly define the phrase "prosthesis horizontal component."

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