Short Communication

Surface Roughness of a Novel Dental Porcelain Following Different Polishing Procedures

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This study aimed to compare the surface roughness of a novel dental porcelain following different polishing procedures. One hundred twenty Imagine Reflex porcelain disks were prepared and randomly assigned into six groups according to different treatments: Group 1: CeraMaster polishing system (CP); Group 2: CP + diamond polishing paste (DP); Group 3: Sof-Lex polishing system (SS); Group 4: SS + DP; Group 5: SiC paper polishing; Group 6: reglazing (control). After the respective treatments, surface roughness values were measured using a profilometer. Qualitative analysis was performed using scanning electron microscopy. Results demonstrated that a combination of the CeraMaster polishing system and a diamond polishing paste could produce similar superficial smoothness to that of the reglazed surface of the tested porcelain. *Int J Prosthodont 2009;22:178–180*

Chairside modifications of glazed dental porcelain surfaces are frequently necessary to adjust occlusal contacts or improve the esthetics of restorations. Such modifications may result in a rough surface and it is therefore necessary to reglaze or polish the ceramic restoration after clinical adjustments have been made. Based on the results of a number of studies,[1–4] it can be suggested that the choice of polishing procedure to achieve the optimum smoothness of porcelain is material-dependent. According to the manufacturer's specifications, Imagine Reflex (IR) porcelain, a newly developed veneer ceramic, contains nanoleucite crystals that are much finer than those of traditional porcelain. In a previous investigation, IR porcelain showed better polishing performance than conventional dental porcelain.[5] The unique microstructure of IR porcelain may also require a different polishing procedure than those recommended for traditional porcelain. This in vitro study was carried out to compare, quantitatively with a profilometer and qualitatively with scanning electron microscopy (SEM), the surface roughness of IR porcelain after different polishing procedures.

Materials and Methods

A total of 120 IR (Wieland Dental + Technik) porcelain disks, 12 mm in diameter and 2 mm in thickness after firing, were fabricated following the manufacturer's instructions The glazed surfaces were ground with medium-grit diamond burs on one side to simulate the clinical adjustment of ceramic restorations. All specimens were randomly divided into six groups with 20 specimens in each group, according to the different treatments listed in Table 1. After their respective treatments, all specimens were subjected to ultrasonic cleaning (Bransonic B-221, Bransonic) in distilled water for 10 minutes and were then dried. Three roughness parameters (Table 2) were recorded with a surface profilometer (Surtronic 3, Taylor Hobson Precision). Representative specimens from each group were used for surface evaluation with SEM at a magnification of $\times$ 500. The data were compared for all groups using one-way analysis of variance (ANOVA) followed by Tukey multiple comparison tests. Differences at $P < .05$ were regarded to be significant.

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Table 1 Surface Treatment Procedures Applied to Porcelain Specimens

	Polishing procedures	Description
Group 1	CeraMaster polishing system (CP)	Test surfaces were polished sequentially with green stones, white stones, CeraMaster coarse polishing points, and CeraMaster polishing points (Shofu Dental)
Group 2	CeraMaster polishing system + diamond polishing paste (CP + DP)	After above treatment, specimens were polished with Ultra II Porcelain Polishing Paste (Shofu Dental)
Group 3	Sof-Lex polishing system (SS)	Test surfaces were polished sequentially with course, medium, fine, and super-fine Sof-Lex disks(3M ESPE Dental) for a standardized time period
Group 4	Sof-Lex polishing system + diamond polishing paste (SS + DP)	After above treatment, specimens were polished with Ultra II polishing paste
Group 5	SiC papers polishing (SP)	Sequentially using 240, 400, 600, 800, 1,000, 1,200, 1,500, and 2,500-grit SiC papers (Suisun), each specimen was rubbed against a sheet of wet SiC paper for 50 strokes of 15 cm in length
Group 6	Reglazing (RG)	Test surfaces were reglazed using the recommended overglaze material (Wieland Dental + Technik)

Table 2 Surface Roughness Parameters Measured and Their Meanings

Roughness parameters	Meanings
R_a	The arithmetical average of surface heights
R_{max}	The magnitude of the peak-to-valley height in all cut-off lengths
R_z	The average height difference between the five highest peaks and five lowest valleys within each cut-off length

Table 3 Roughness Values of IR Porcelain Specimens Following Different Surface Treatments (μm) (n = 20)*

	R_a (± SD)	R_{max} (± SD)	R_z (± SD)
Group 1	0.26 (0.06)[a]	2.17 (0.17)[a]	1.47 (0.15)[a]
Group 2	0.20 (0.08)[b]	1.70 (0.41)[b]	1.22 (0.11)[b]
Group 3	0.48 (0.16)[c]	2.83 (0.24)[c]	1.84 (0.26)[c]
Group 4	0.45 (0.12)[c]	2.96 (0.22)[c]	1.85 (0.35)[c]
Group 5	0.32 (0.07)[d]	2.44 (0.46)[d]	1.34 (0.16)[a]
Group 6	0.19 (0.03)[b]	1.54 (0.32)[b]	1.08 (0.23)[b]

*Values with the same superscripts were not significantly different at the $P < .05$ level for the same parameter.

Results

Surface roughness values for the six groups are listed in Table 3. Specimens in Group 2 and Group 6 had the lowest roughness values for all three parameters, which were significantly different from those produced by other polishing procedures ($P < .05$). No significant difference was found between the two groups ($P > .05$). Groups 3 and 4 showed significantly high roughness values ($P < .05$), and again, no difference was found between them ($P > .05$).

The SEM findings (Figs 1a to 1f) had good correlation with the surface roughness values measured with the profilometer. Surfaces of specimens in Group 2 and Group 6 appeared to be the smoothest with very few irregularities (Figs 1b and 1f). The surfaces polished with the Sof-Lex polishing system seemed to be less smooth than those obtained by other treatments, showing obvious grooves and numerous irregular types of porosities dispersed throughout the surfaces (Figs 1c and 1d). Specimens polished with sequential SiC papers were characterized by various grooves and valleys in multiple directions (Fig 1e).

Discussion

In this study, subsequent use of a diamond polishing paste could possibly further decrease the roughness values of IR porcelain polished with the CeraMaster polishing system, producing a similar surface to the reglazed one. This result can likely be explained by the observation that CeraMaster polishers may leave a residue on the surface of the ceramic, which could be removed by the subsequent use of a diamond polishing paste. The Sof-Lex polishing system was less effective for polishing IR porcelain when compared to the other treatments. The authors speculated that the higher roughness values in Groups 3 and 4 were mainly due to widely distributed porosities and obvious grooves along the polishing direction (Figs 1c and 1d). The results seemed to disagree with the study by Martinez-Gomis et al,[4] in which the Sof-Lex polishing system exhibited the best polishing performance. The difference in microstructure and leucite crystal size between the IR porcelain and IPS Empress tested in that study[4] may be accountable for the different polishing results, even though the same polishing system was used.

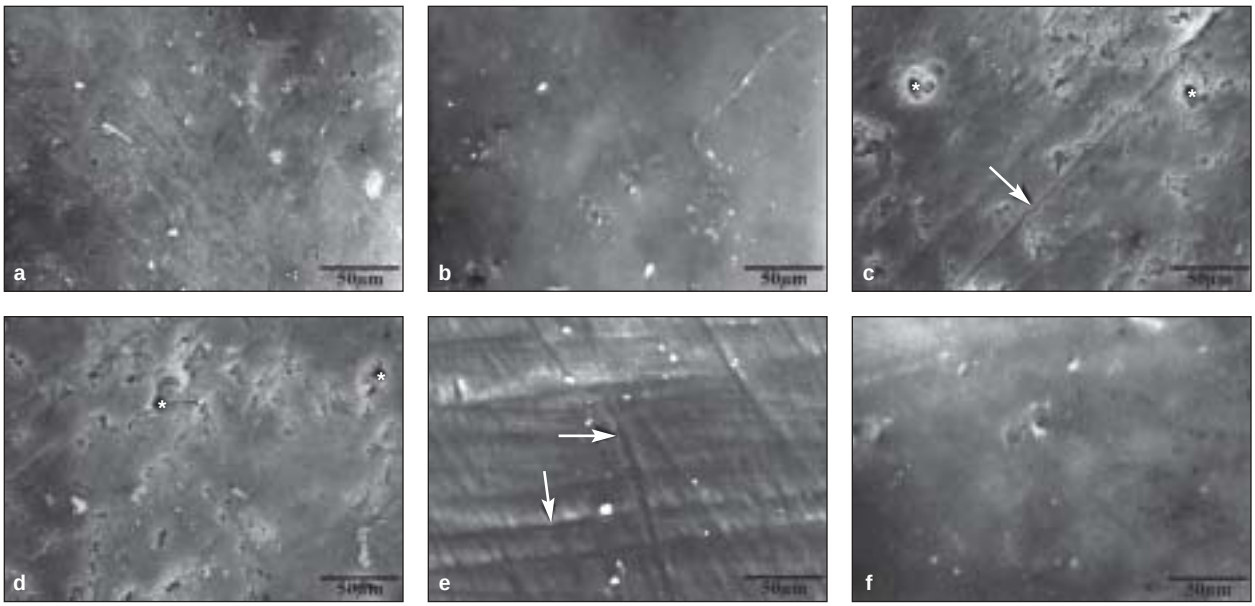

Fig 1 SEM photomicrographs (×500) of porcelain surfaces following different treatments: **(a)** CP, **(b)** CP + DP, **(c)** CS, **(d)** CS + DP, **(e)** SiC paper polishing, **(f)** reglazing. There appeared obvious grooves *(arrow)* and numerous irregular types of porosities *(asterisks)* dispersed throughout the surfaces **(c and d)** as well as various grooves and valleys in multiple directions *(arrow)* **(e)** on the micrographs.

Conclusion

Taking into account the limitations of this study, combining the CeraMaster polishing system and a diamond polishing paste could produce a similar superficial smoothness to that of the reglazed surface on IR porcelain, while the Sof-Lex polishing system was the least effective in polishing IR porcelain.

References

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