Short Communication

The Effects of Extraoral Porcelain Polishing Sequences on Surface Roughness and Color of Feldspathic Porcelain

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The aim of this study was to evaluate the surface properties and color of porcelain modified by extraoral polishing sequences. Six different surface treatment regimens (diamond burs, self-glaze, overglaze, reglaze, Pearl Surface polishing system, and Diamond Twist SCL) were applied to 60 porcelain disks (n = 10 per group). Profilometry and atomic force microscopy (AFM) were used for the determination of surface roughness (*Ra*); color changes (ΔE^*) were investigated by spectrophotometry. Statistical comparisons were made using analysis of variance, the Kruskal-Wallis test, and the Pearson correlation coefficient test. Surface treatments significantly affected *Ra* values ($P < .001$) but had no effect on color ($P > .05$). AFM findings were consistent with *Ra* values. Color did not appear to be correlated with surface roughness ($P > .05$). The findings concluded that the Pearl Surface system helps to decrease chairside time and may be used as an alternative to overglazing. *Int J Prosthodont 2009;22:472–475.*

Adjustments to glazed porcelain surfaces due to extraoral grinding produce a roughened surface that can lead to plaque accumulation, wear of the opposing dentition, staining, and a decrease in strength.[1,2] Various procedures including self-glazing, overglazing, and special kits[1,3–5] have been advocated for this purpose. However, there is a lack of consensus on the best polishing method or technique, especially with regard to surface roughness and color change.[1,6,7]

The aim of the present study was to evaluate the surface roughness and color of feldspathic porcelain modified by different extraoral polishing sequences.

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Materials and Methods

Sixty feldspathic dentin porcelain disks (10 mm in diameter, 2 mm thick, fired at 930°C, shade: A2; Noritake Super Porcelain EX-3) were randomly assigned to six groups (n = 10) according to the surface treatment method tested (Table 1). Table 2 shows all instruments and polishing kits used in this study. The surfaces were initially finished with medium-grit (6863, Komet Dental) and fine-grit diamond rotary cutting instruments (8863, Komet Dental) consecutively using a slow-speed handpiece (NSK) at 10,000 rpm. Thereafter, the specimens were ultrasonically treated in distilled water and dried at room temperature.

Surface roughness (*Ra*) measurements were performed using a Surftest SJ-201P profilometer (Mitutoyo) with a cut-off value of 0.8 mm and a measuring length of 4 mm. The mean roughness value of each specimen was calculated after five tracings.

Three-dimensional 50 µm × 50 µm images of the specimen surfaces were obtained using an atomic force microscope (AFM) (EasyScan 2 AFM, Nanosurf).

Table 1 Specimen Groups Classified in Accordance to Surface Treatment

Group	Surface treatment
1	Ground (medium- and fine-grit diamond burs)
2	Ground + self-glazed (initial firing temperature = 650°C; raised 50°C/min until 930°C)
3 (control)	Ground + overglazed (Initial firing temperature = 650°C; raised 50°C/min until 910°C)
4	Overglazed + ground + overglazed (reglazed)
5	Ground + Pearl Surface (S-Yellow + S-Green + Pearl Surface C + Pearl Surface F)
6	Ground + Diamond Twist SCL (prepolishing with open weave prepolishers + diamond twist supercharged polishing paste)

Table 2 Instruments and Polishing Kits Used in the Study

Material	Product	Manufacturer
Diamond bur	Medium- and fine-grit diamond rotary cutting instrument	Komet Dental, Gebr Brasseler
Extraoral polishing kit	Pearl Surface Pearl Surface C Pearl Surface F Felt wheel	Noritake Dental Supply
Paper abrasive material	Noritake Meister Cones S-Green (small/fine) S-Yellow (small/medium)	Noritake Dental Supply
Extraoral polishing kit	Diamond Twist SCL Fibra points Wool paste applicators Diamond twist supercharged polishing paste	Premier Dental Products

Table 3 Average Surface Roughness and Mean CIE L^*, a^*, b^*, and ΔE* Values According to Surface Treatments

		Mean ± SD			
Group	*Ra* (μm)	ΔE*	L^*	a^*	b^*
1	1.62 ± 0.14	0.89 ± 0.41	71.36 ± 0.45	0.99 ± 0.10	15.49 ± 0.55
2	0.90 ± 0.10	0.89 ± 0.41	71.56 ± 0.50	1.09 ± 0.11	15.96 ± 0.39
3	0.89 ± 0.22	0.83 ± 0.44	71.32 ± 0.50	1.02 ± 0.11	15.70 ± 0.25
4	0.82 ± 0.10	0.62 ± 0.41	71.45 ± 0.51	1.11 ± 0.07	16.03 ± 0.26
5	0.89 ± 0.06	0.81 ± 0.30	71.54 ± 0.53	0.96 ± 0.12	15.72 ± 0.28
6	1.17 ± 0.12	0.91 ± 0.47	71.32 ± 0.53	0.99 ± 0.10	15.91 ± 0.32

Ra = average surface roughness; SD = standard deviation.

Color change (ΔE*) is defined by the difference between Commission Internationale de l'Eclairage (CIE) L^*, a^*, and b^* coordinates of the same or different specimens at different instances. L^*, a^*, and b^* represent lightness, the green-red axis ($+a^*$= red; $-a^*$= green), and the yellow-blue axis ($+b^*$= yellow; $-b^*$= blue), respectively. $\Delta E^* \geq 3.3$ was considered to be visually perceptible and clinically unacceptable.[2] Color was measured using a Minolta CM-3600d spectrophotometer according to the following equation:

$$\Delta E^* = [(L^*_E - L^*_3)^2 + (a^*_E - a^*_3)^2 + (b^*_E - b^*_3)^2]^2$$

where $(L^*_E - L^*_3)$,$(a^*_E - a^*_3)$, and $(b^*_E - b^*_3)$ are the differences in ΔL^*, Δa^*, and Δb^* values, respectively; '$_E$' and '$_3$' represent the values obtained from experimental specimens and the control group.

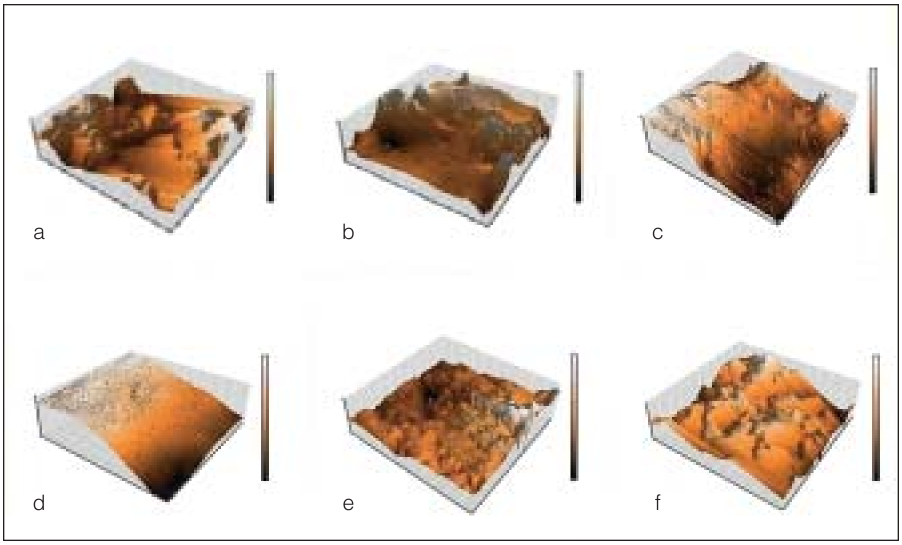
Ra and color values were analyzed using one-way analysis of variance and the Tukey post hoc honestly significant difference (HSD) test at a significance of $\alpha = .05$. ΔE* values were analyzed using the Kruskal-Wallis test ($\alpha = .05$). A possible association between L^*, a^*, b^*, and *Ra* values was evaluated using the Pearson correlation test with a Bonferroni correction.

Results

The surfaces of groups 2, 3, 4, 5, and 6 were significantly smoother than those of group 1 ($P < .001$). The surfaces of groups 2, 3, 4, and 5 were significantly smoother than those of group 6 ($P < .001$) (Table 3).

The AFM images were consistent with the profilometry results (Fig 1). Accordingly, groups 1 and 6 showed nonuniform surfaces with distinct sharp projections (Figs 1a and 1f). The surfaces of groups 2, 3, 4, and 5 (Figs 1b to 1e) had a smoother appearance compared with groups 1 and 6. However, groups 2 and 3 appeared to have needle-like eaves (Figs 1b and 1c) and groups 4 and 5 demonstrated low profile, moderately irregular surfaces (Figs 1d and 1e).

There were no significant differences among the test groups with respect to L^* and ΔE* values ($P > .05$). Group 4 showed higher a^* values compared to group 5 ($P < .05$); groups 2 and 4 showed higher b^* values compared to group 1 ($P < .05$) (Table 3). No linear correlation was observed between the test parameters, color, and surface roughness ($P > .05$).



Figs 1a to 1f Three-dimensional AFM images of **(a)** group 1, **(b)** group 2, **(c)** group 3, **(d)** group 4, **(e)** group 5, and **(f)** group 6.

Table 4 Characteristics of In Vitro Studies Investigating Porcelain Polishing Systems

Study	Porcelain materials	Glazing and polishing procedures	Method of evaluation: Qualitative	Method of evaluation: Quantitative	Conclusion
Chu et al[8]	In Ceram cores with Vitadur Alpha veneer	Ultradent diamond polishing paste, overglaze, reglaze	SEM	Profilometer	Reglaze > overglaze, Ultradent diamond polishing paste
Kim et al[7]	Conventional (Vita Omega 900)	200-, 400-, 1,000-, and 1,500-grit SiC papers, overglaze,	–	Spectro-photometer, profilometer	Glazed ≈ 400-, 1,500-grit SiC paper
Wright et al[4]	Ultra-low fusing (Finesse)	Jelenko, Axis Dental, Brasseler	SEM	Profilometer	All systems > autoglaze Axis > Jelenko, Brasseler
Sarac et al[5]	Conventional (Vitadur Alpha)	Ultra II; Diamond Stick, CeraMaster, Shofu Dental porcelain adjustment kit, overglaze	SEM	Colorimeter, profilometer	Shofu Dental, Ultra II, Diamond Stick = overglaze
Al-Wahadni[9]	Leucite based (IPS Empress II); In Ceram cores with Vitadur Alpha veneer	Shofu porcelain veneer kit, overglaze	-	Profilometer	Overglaze ≈ Shofu porcelain veneer kit
Aksoy et al[3]	Conventional (Ceramco II)	Autoglaze, overglaze; diamond fraising, stoning, sanding, aluminum oxide	SEM	AFM	Overglaze > all other procedures

SEM = scanning electron microscope, > = produces smoother surfaces, ≈ = produces as smooth surfaces.

Discussion

There are conflicting reports on the surface characteristics of polished, glazed, or unaltered porcelain surfaces.[6,8] Table 4 summarizes the materials, evaluation methods, and conclusions of recent studies that have investigated porcelain polishing systems. Differences among studies concerning *Ra* may be caused by variations in polishing instruments, operators, evaluation methods,[8] or abrasive particle dimensions of polishing pastes. A systematic decrease in particle size improves smoothness. Unlike Pearl Surface, Diamond Twist SCL was unable to fulfill the manufacturer's claim of recreating a "glaze-like finish," which might be attributed to the aforementioned factors.

As observed by AFM, finishing with diamond burs alone produces rough surfaces. The AFM images for groups 4 and 5 showed lower profiles when compared to groups 2 and 3, despite not having significantly different *Ra* values. It is important to differentiate between surface integrity and a quantitative measure of surface smoothness. These factors are not necessarily synonymous in so far as a refinished porcelain surface devoid of glaze could be virtually identical to a glazed surface in terms of its surface characteristics, such as wear, abrasion resistance, stain absorption,[6] and surface roughness, as seen in the present study. Also, based on the AFM findings of the current investigation, reglazing clearly reduces the surface roughness of flaws left after porcelain polishing, which can be seen among groups 4 and 5.

In the present study, the color change between the control and experimental groups was not perceivable ($\Delta E^* < 3.3$). *Ra* values were significantly different for groups 1 and 2. However, DE* were identical in all groups. These results indicate that porcelain color may be influenced by other surface characteristics rather than *Ra* values alone.

Kim et al[7] found that surface topography influences the CIE *a** and *b** values by showing that these values were higher for reglazed and self-glazed groups compared with others. Texture, curvature, and gloss of porcelain all vary depending on surface treatments, and the light striking the surface is modified resultantly.[7]

Inevitably, the evaluation of only one type of porcelain can be criticized. Further investigations should be done using different types of porcelains and polishing techniques to investigate this concept. Extraoral polishing methods may be an option to achieve a surface equal to or better than overglazing.

References

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Literature Abstract

Physical activity correlates and barriers in head and neck cancer patients

The purpose of this cross-sectional clinical study was to identify the correlates and barriers of physical activity in head and neck cancer patients. A convenient sample of 59 patients (82% men, 92% white) with a history of head and neck cancer were recruited at an academic outpatient clinic to participate in this study. Participants filled out a series of self-administered surveys. For self-reported physical activity, a modified Godin Leisure-Time Exercise questionnaire was used. Confidence, barriers to physical activity, and social support were measured on Likert-type scales. Barrier self-efficacy, or the self-assessed ability of a person to overcome perceived barriers, was recorded on a scale adapted for head and neck cancer patients. Task self-efficacy refers to the ability to perform specific tasks, and this was scored on a four-item scale. The presence of physically active role models was evaluated using three yes/no questions. Depression was measured using the Center for Epidemiological Studies-Depression scale. Symptoms were evaluated using the FACT Head and Neck questionnaire. Demographics and medical history were obtained from the participants and their medical charts. The subject population was found to be mostly inactive and results show that activity levels decreased after diagnosis. For the data analysis, Pearson correlations were used to obtain physical activity correlates and covariates. Stepwise linear regression was then used to determine independent correlates from the variables with significant zero order associations with physical activity. The results of this clinical study suggest that enjoyment of exercise ($r = 0.41$), symptom index ($r = -0.36$), alcohol use ($r = 0.36$), task self-efficacy ($r = 0.33$), perceived barriers ($r = -0.27$), and comorbidity ($r = -0.27$) are significant factors that contribute to physical activity in head and neck cancer patients. Symptoms associated with head and neck cancer and treatments that impeded physical activity with significant barriers were dry mouth ($r = -0.32$), fatigue ($r = -0.27$), drainage in the mouth or throat ($r = -0.41$), difficulty eating ($r = -0.32$), shortness of breath ($r = -0.30$), muscle weakness ($r = -0.29$), difficulty swallowing ($r = -0.28$), and decreased food intake ($r = -0.28$). Results of this study suggest that physical symptoms associated with head and neck cancer and treatment are significantly associated with low levels of physical activity. Psychologic variables (ie, enjoyment) also significantly affect activity levels in head and neck cancer patients.

Rogers LQ, Courneya KS, Robbins KT, et al. *Support Care Cancer* 2008;16:19–27. **References:** 39. **Reprints:** Dr Laura Q. Rogers, Department of Medicine, SIU School of Medicine, PO Box 19636 Springfield, IL 62794-9636. Email: lrogers@siumed.edu—*Alvin G. Wee, UNMC Dept Otolaryngology, Omaha, NE*