Short Communication

Comparison of 3 Polishing Techniques for 2 All-Ceramic Materials

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The aim of this study was to compare the surface roughness produced by polishing 2 all-ceramic materials after surface conditioning. Air particle abrasion (APA) with 25-μm aluminum oxide, 9.6% hydrofluoric acid (HFA,) and APA + HFA were applied for ceramic surface conditioning. Subsequently, the ceramics were subjected to 3 polishing techniques: polishing kit, polishing paste, and polishing kit + polishing paste. Surface roughness (Ra) was evaluated profilometrically. The highest ΔRa values were obtained with the polishing kit and polishing kit + paste for the APA + HFA groups. No significant differences were observed among the polishing paste groups. Combining a polishing kit and polishing paste produced the smoothest ceramic surfaces. *Int J Prosthodont 2007;20:465–468.*

Today, orthodontists are often faced with the challenge of bonding brackets to all-ceramic restorations. When a porcelain surface is involved, airborne particle abrasion (APA), diamond burs, acids, and silanization are used to provide adequate bond strength.[1,2] Roughened porcelain may cause an increased rate of plaque accumulation, producing adverse soft tissue reactions.[3] Therefore, the porcelain must be reglazed or polished after orthodontic treatment.

The objective of this study was to compare the surface roughness produced by 3 polishing techniques on 2 all-ceramic materials subjected to 3 surface conditioning methods. The research hypothesis was that polishing techniques after surface conditioning would have different effects on the surface roughness of porcelain.

Materials and Methods

Sixty-three feldspathic (Vitadur Alpha, Vita Zahnfabrik) and 63 lithium disilicate (Empress 2, Ivoclar Vivadent) ceramic specimens (10 × 10 × 3 mm) were glazed and randomly divided into 3 groups. In group 1, APA was performed using 25-μm aluminum oxide (Al_2O_3) from a distance of approximately 10 mm at a pressure of 2.5 bars for 4 seconds. In group 2, the ceramic surfaces were etched with 9.6% hydrofluoric acid (HFA) (Porcelain Etch Gel, Pulpdent) for 2 minutes. In group 3, APA plus HFA were applied. The surface roughness was evaluated using a profilometer (Surftest 402, Mitutoyo).

Following profilometric analysis, each group was divided into 3 subgroups (n = 7). The first, second, and third subgroups were polished with a polishing kit (Porcelain Adjustment Kit, Shofu), polishing paste (Diamond Stick, Shofu), and polishing kit plus polishing paste, respectively (Table 1). After these procedures, the second profilometric measurements were made. The changes of surface roughness (ΔRa) were obtained by subtracting the second profilometric readings from the first readings. Three-way analysis of variance for (3 × 3) × 7 factorial design was performed to determine significant differences among ceramic materials, surface conditioning methods, polishing techniques, and their interactions. All treatment combination means for ΔRa values were also compared using the Tukey multiple comparison test ($\alpha = .05$).

To evaluate the surface conditioning and polishing methods for each ceramic, 12 additional specimens representing each surface conditioning and polishing method were prepared. Thus, 24 specimens and 2 intact glazed specimens for each ceramic were examined under a scanning electron microscope (SEM) (JSM-6335F, Jeol).

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Table 1 Subgroups According to Ceramic Type, Surface Conditioning Method, and Polishing Technique

Ceramic	Surface treatment	Polishing technique	Group
Feldspathic (F)	APA with 25-μm Al_2O_3 (A)	K	FAK
		P	FAP
		KP	FAKP
	9.6% hydrofluoric acid, 2 min (H)	K	FHK
		P	FHP
		KP	FHKP
	APA with 25-μm Al_2O_3 + 9.6% hydrofluoric acid, 2 min (AH)	K	FAHK
		P	FAHP
		KP	FAHKP
Lithium disilicate (L)	APA with 25-μm Al_2O_3 (A)	K	LAK
		P	LAP
		KP	LAKP
	9.6% hydrofluoric acid, 2 min (H)	K	LHK
		P	LHP
		KP	LHKP
	APA with 25-μm Al_2O_3 + 9.6% hydrofluoric acid, 2 min (AH)	K	LAHK
		P	LAHP
		KP	LAHKP

K = polishing kit; P = polishing paste; PK = polishing kit + polishing paste.

Table 2 Three-Way Analysis of Variance of Mean ΔRa

Source of variation	Type III sum of squares	*df*	Mean square	F	*P*
Ceramic	0.694	1	0.694	17.062	.000
Surface conditioning	31.534	2	15.767	387.733	.000
Polish	55.649	2	27.825	684.258	.000
Ceramic / surface conditioning	0.784	2	0.392	9.641	.000
Ceramic / polish	0.229	2	0.114	2.814	.064
Surface / polish	14.976	4	3.744	92.071	.000
Ceramic / surface conditioning / polish	0.802	4	0.201	4.933	.001
Error	4.392	108	0.041	–	–
Corrected total	109.060	125	–	–	–

Table 3 Mean ΔRa, Minimum and Maximum Values, and SDs for Each Group (n = 7)

Group*	ΔRa	SD	Maximum	Minimum	Homogenous subset
FAHKP	2.70	0.17	2.39	2.89	A
LAHKP	2.62	0.37	1.97	3.15	A
FAHK	2.19	0.22	1.92	2.46	A
LAHK	2.33	0.19	1.93	2.50	A
LAKP	2.13	0.52	1.47	2.72	B
LAK	2.07	0.26	1.75	2.29	B
FAK	1.88	0.24	1.73	2.30	B
FAKP	1.42	0.24	1.12	1.72	B
LHKP	0.91	0.15	0.67	1.08	C
FHKP	0.75	0.18	0.51	1.07	C
FHK	0.57	0.13	0.42	0.77	CD
LHK	0.57	0.21	0.34	0.93	CD
LAHP	0.42	0.24	0.15	0.80	D
LAP	0.37	0.19	0.12	0.55	D
FHP	0.33	0.09	0.22	0.45	D
FAHP	0.21	0.14	0.05	0.45	D
FAP	0.19	0.10	0.06	0.30	D
LHP	0.13	0.04	0.08	0.18	D

*See Table 1.

Results

Significant effects were found for the porcelain types, surface conditioning methods, and polishing methods on the ΔRa values ($P < .001$, Table 2). There were also significant interactions between the ceramic materials and surface conditioning methods and surface conditioning methods and polishing techniques ($P < .001$), but no significant interaction was observed between ceramic materials and polishing techniques ($P > .05$). There was a significant interaction among ceramic materials, surface conditioning methods, and polishing techniques ($P < .001$). The results of the Tukey multiple comparison test to compare the mean differences of ΔRa values are given in Table 3.

The highest mean ΔRa values were observed for ceramic materials treated with APA plus HFA for the polishing kit and polishing kit plus paste groups. No significant differences were found among the groups polished with polishing paste ($P > .05$). For each ceramic material, there was no significant difference

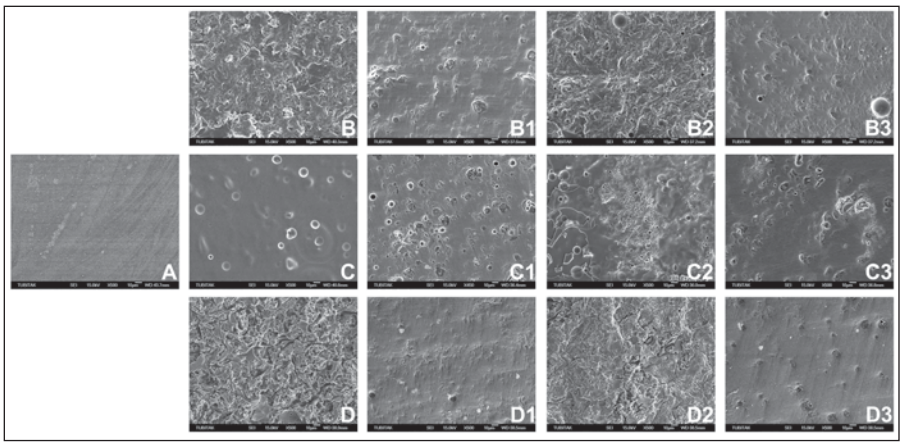

Fig 1 Scanning electron photomicrographs of feldspathic ceramic (×500 magnification): **(a)** intact glazed surface; **(b)** APA application; **(b1)** polishing kit; **(b2)** polishing paste; **(b3)** polishing kit + paste; **(c)** HFA application; **(c1)** polishing kit; **(c2)** polishing paste; **(c3)** polishing kit + paste; **(d)** APA + HFA application; (d1) polishing kit; **(d2)** polishing paste; **(d3)** polishing kit + paste.

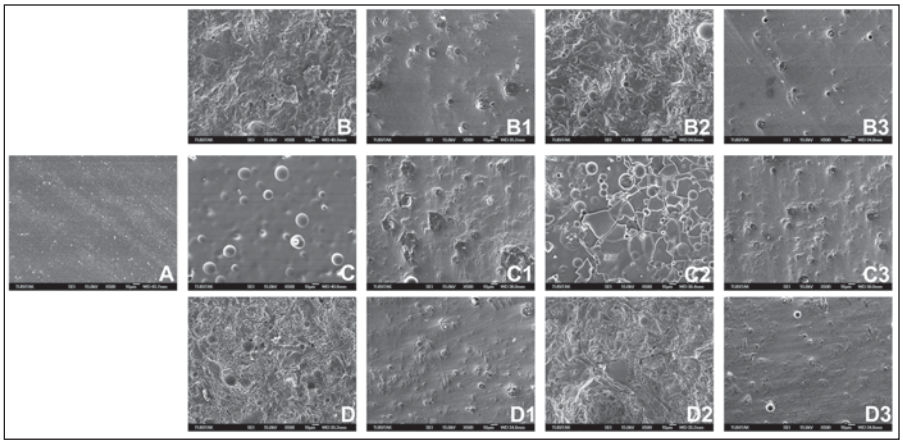

Fig 2 Scanning electron photomicrographs of lithium disilicate ceramic (×500 magnification): **(a)** intact glazed surface; **(b)** APA application; **(b1)** polishing kit; **(b2)** polishing paste; **(b3)** polishing kit + paste; **(c)** HFA application; **(c1)** polishing kit; **(c2)** polishing paste; **(c3)** polishing kit + paste; **(d)** APA + HFA application; **(d1)** polishing kit; **(d2)** polishing paste; **(d3)** polishing kit + paste.

among the groups treated with HFA for the polishing kit and polishing kit plus paste groups ($P > .05$).

The SEM photomicrographs demonstrated that the roughest surfaces were obtained with APA plus HFA, and that the use of a polishing kit and polishing kit plus paste presented smoother surfaces than the use of polishing paste alone (Figs 1 and 2). Polished surfaces did not present a surface as smooth as the original glazed surface.

Discussion

When the ΔRa values were compared, it was observed that the highest mean ΔRa values were obtained for ceramic materials treated with APA plus HFA and polished with a polishing kit or polishing kit plus paste. The reason for this finding was the creation of rougher surfaces with APA plus HFA. The SEM photomicrographs verified this finding.

The polishing kit plus paste presented smoother surfaces than the polishing kit and polishing paste alone. This finding is in agreement with several previous reports investigating the effect of different polishing techniques on the surface roughness of different ceramics. Based on profilometry, it was reported that polishing can produce surfaces as smooth as the original glaze.[3,4] These authors recommended a polishing kit for smoothing porcelain if used in conjunction with a polishing paste containing fine diamond particles.[3,4] The result of the present study showed that the use of polishing paste alone did not significantly improve the ceramic surface smoothness. However, polishing paste offers a slight improvement when used after the polishing kit.[4] The SEM photomicrographs showed that regardless of which type of polishing technique was applied, it was impossible to restore the ceramic surface to its original glazed state.

In this study, lithium disilicate ceramic displayed smoother surfaces. Lithium disilicate ceramic is prepared with the vacuum-press technique, leading to a more homogeneous product.[5]

Conclusions

Under the conditions of this in vitro study, the following conclusions were drawn:

1. The smoothest surfaces were obtained by combining a polishing kit and polishing paste. Polishing paste application alone did not improve the smoothness of the ceramics.
2. Lithium disilicate ceramic showed smoother surfaces than feldspathic ceramic.

References

1. Özcan M, Vallittu PK, Peltomäki T, Huysmans MC, Kalk W. Bonding polycarbonate brackets to ceramic: Effects of substrate treatment on bond strength. Am J Orthod Dentofacial Orthop 2004;126:220–227.
2. Schmage P, Nergiz I, Herrmann W, Özcan M. Influence of various surface-conditioning methods on the bond strength of metal brackets to ceramic surfaces. Am J Orthod Dentofacial Orthop 2003;123:540–546.
3. Wright MD, Masri R, Driscoll CF, Romberg E, Thompson GA, Runyan DA. Comparison of three systems for the polishing of an ultra-low fusing dental porcelain. J Prosthet Dent 2004;92:486–490.
4. Fuzzi M, Zaccheroni Z, Vallania G. Scanning electron microscopy and profilometer evaluation of glazed and polished dental porcelain. Int J Prosthodont 1996;9:452–458.
5. Anusavice KJ. Dental ceramics. In: Anusavice KJ (ed). Phillips' Science of Dental Materials. Philadelphia: WB Saunders, 2003:655–719.

Literature Abstract

Development and pilot testing of a psychoeducational intervention for oral cancer patients.

The purpose of this pilot clinical trial was to develop, validate, and test a psychoeducational intervention for patients that have been diagnosed with oral cancer and will undergo surgical treatment. A 95-page booklet with color illustrations entitled "What to Expect from your Oral Cancer Surgery: A guide for Patient and Families" was developed by a multi-disciplinary team. The language was written at an eighth grade reading level. All eligible patients met with the research coordinator who explained the trial. If the patient consented to the study, a self-report baseline assessment package was completed and a random numbers table was used to assign the patients into either the intervention arm or control arm. For the intervention arm, presentation of the contents of the psychoeducational booklet to patients by a research nurse was divided into two parts, a preoperative and pre-discharge intervention. Each contact was between 60 to 90 minutes to discuss the contents of the booklet. A further follow-up assessment occurred at 3-months post-discharge. The control arm received the standard of care, which consisted of meeting the surgeon at the time of consent for the surgery to provide brief description of information about the illness and proposed treatment. Relevant members of the team also met with the patient. The self-report baseline included the following: sociodemographic data, TNM cancer stage, tumor history, surgical procedures, further treatment, disease status, clinical complications, Observer-Rated Disfigurement Scale, history of alcoholism, MOS Social Support Survey, oral cancer knowledge questionnaire, Stanford Inventory of Cancer Patient Adjustment, State-Trait Anxiety Inventory, Center for Epidemiologic Studies-Depression scale, Affect Balance scale, Measure of Body Image, Atkinson Life Happiness Rating scale, Illness Intrusiveness Rating scale, EORTC, and a 5-item satisfaction survey. A mixed analysis of variance (ANOVA) was used to examine group and time interaction. Post-hoc analyses were done using *t* tests only if repeated-measures ANOVA were significant. A total of 19 patients were recruited (10 intervention and 9 control) for the study. The intervention group showed a gain in knowledge, less body image disturbance, lower anxiety, and a trend toward higher well-being.

Katz MR, Irish JC, Devins GM. *Psychooncology* 2004;13:642–653. **References:** 84. **Reprints:** Mark R. Katz, University Health Network, Princess Margaret Hospital, 610 University Avenue, Psychiatry/Psychosocial Oncology and Palliative Care 5-634, Toronto, Ontario, Canada M5G 2M9. E-mail: mark.katz@uhn.on.ca—*Alvin G. Wee, OSU College of Dentistry, Columbus, OH*