Original Articles

EVALUATION OF A NEW EXPERIMENTAL PASTE IN POLISHING UNGLAZED PORCELAIN

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هناك العديد من المواد والتقنيات المستخدمة لإعادة إنهاء وتلميع الخزف المسحول. غالبية المواد المستخدمة في التلميع النهائي للخزف هي عبارة عن معاجين محتوية على بودرة الألماس بتكلفة مرتفعة نسبياً.

يستخدم صانعوا الزجاج التجاري مواد تلميع غير مكلفة للحصول على أسطح ملساء بنفس درجة نعومة الأسطح الخزفية.

الهدف من هذه الدراسة هو تقويم إحدى معاجين التلميع المستخدمة من صناعة الزجاج التجاري ومدى فعاليتها في تلميع الخزف السني، وأيضاً مقارنتها بعدة طرق مستخدمة من قبل أطباء الأسنان في تلميع السطح الخارجي للخزف المحول مثل طريقة التلميع الحراري الذاتي والتلميع بالسائل الزجاجي والتلميع اليدوي باستخدام ملمعات شوفو المطاطية وباستخدام معجون يحتوي على بودرة الألماس.

تم تحضير ٢٥ عينة خزفية مسطحة متماثلة ومجهزة بطريقة معيارية ثابتة بأسطح خارجية ملمعة تلميعاً حرارياً ذاتياً، المجموعة الأولى تحتوي على خمسة عينات ترك سطحها الخارجي كما هو، أما العينات المتبقية فقد أزيلت منها الأسطح اللامعة وقسمت إلى أربعة مجموعات كل مجموعة تحتوي على خمسة عينات. إحدى المجموعات لمعت بالسائل الزجاجي، وأخرى بملمعات شوفو المطاطية، وأخرى بمعجون (فيادنت) المحتوي على بودرة الألماس، والمجموعة الأخيرة بالمعجون التجريبي المستخدم في تلميع الزجاج التجاري. وقورنت درجة خشونة العينات الخزفية بواسطة مقياس الخشونة المجهري إضافة إلى ذلك تمت دراسة خشونة السطح الخارجي لبعض العينات الخزفية تحت المجهر الإلكتروني. وأظهرت المقارنة الإحصائية أن درجة خشونة الأسطح الملمعة بالمعجون التجريبي شبيهة بتلك الملمعة بطريقة التلميع الحراري الذاتي والتلميع اليدوي باستخدام معجون شوفو أو فيادنت ولكن التلميع بالسائل الزجاجي نتج عنه أسطح خشنة مقارنة مع الطرق الأخرى المذكورة أعلاه.

Various materials and techniques are used for refinishing ground dental porcelain. Most of the final polishing materials are diamond pastes and are quite expensive. Industrial glass manufacturers use inexpensive polishing materials to attain essentially the same degree of polish as porcelain. One such industrial polish was compared to auto glazing, liquid glazing and two polishing techniques as to rendering ground dental porcelain smooth. Twenty-five specimens were made from Vita porcelain and autoglazed. One group of five specimens was left as is. The other twenty specimens were ground to remove the glaze layer then were divided into four groups of five specimens each. One group was liquid glazed. Two groups were refinished and polished using a dental porcelain adjustment system with and without polishing

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paste. The last group was refinished but polished with an industrial glass polishing paste. Roughness of the specimen surfaces were determined by using a surface roughness microanalyzer. Specimens from each group were examined under the SEM. Statistical analysis showed that the industrial glass polish produced a surface as smooth as the autoglazed surface and as two of the porcelain polishing techniques. Liquid glazing produced a surface significantly more rough than the other four treatments.

Introduction

Porcelain has been available as a restorative material for over 150 years.[1] The material is widely used mainly because of its aesthetic qualities. There are numerous instances in laboratory and clinical practice when it is necessary to adjust an autoglazed porcelain surface by grinding.[2] The resulting break in the glazed surface need not be ignored. Monasky and Taylor[3] demonstrated an increased potential for wear of occlusal surfaces opposed by a ground porcelain surface. Podshadley and Harrison[4] reported that an unglazed porcelain surface in contact with soft tissues can elicit an unfavorable response. Hence, ground porcelain surfaces, if not glazed, should be polished thoroughly to eliminate the rough surface layer.[5] Various techniques have been used for refinishing ground porcelain[6] and several porcelain refinishing diamond pastes are now available commercially. These diamond pastes are capable of restoring adjusted porcelain to a degree of surface smoothness comparable to that of glazed porcelain.[79] Actually, many ceramists advocate polishing, rather than glazing, to control the surface luster, glossiness and the aesthetic result of the ceramic restoration.[10] However, these commercial pastes are expensive.

Industrial glass manufacturers consume an abundance of polishing agents for the purpose of finishing and polishing their products. These polishing agents are readily available and quite inexpensive.

The purpose of this study was to evaluate the effectiveness of one of the industrial glass polishing agents in refinishing ground dental porcelain surface. Further, the efficiency of the glass polishing agent relative to four porcelain finishing techniques is compared, both quantitatively and qualitatively.

Materials and Methods

Twenty-five porcelain specimens were made using Vita VMK-68 porcelain* of which each specimen was 1 x1 x 0.4 cm in size. The specimens were prepared in a standardized manner. Each specimen was fired in an aluminum split mold and autoglazed at 940°C. All specimens were prepared in one batch using the same furnace and according to the manufacturer's directions. The specimens were divided randomly into five groups, each consisting of five specimens.[811] Each specimen was embedded in an acrylic block to facilitate a firm grip during polishing. In group 1 (AG) no treatment was provided; the surface was left with the autoglazed layer. The surfaces of the four remaining groups were ground with an abrasive stone** to remove the glazed layer. Grinding was performed in one direction and always at 90°C angle to the previous polishing direction to obtain undirectional abrasion marks on porcelain. Specimens in Group 2 (LG) were then glazed with a liquid glaze.*** Group 3 (SH) was refinished with Shofu porcelain polishing kit.**** Specimens in Group 4 (VV) were refinished with a diamond impregnated rubber disk then polished with Vident porcelain finishing paste.***** Specimens in Group 5 (GS) were finished with a diamond impregnated rubber disk (Vident) then polished with a creamy consistency of the experimental polishing powder [Gaylussite $Na_2Ca(C0_3)_2.5\ H_20$; white, grayish Monoclinic with a specific gravity of 1.991 and hardness of 2.5 - 3] using a rag wheel.

* Vita Bad Sackingen, Germany
** Ash, Alpine, Detrey, GmbH
*** Vitachrome L725, Vita
**** Shofu Dental Corp., Menlo Park, California, USA
***** Vident, Baldwin Park, California, USA
t Surtronic 3, Rank Taylor, Hobson, Leicester, England
tt Jeol, JSM-T330A Scanning Microscope, Jeol Ltd., Nakagami
Akishima, Tokyo, Japan

To simulate a clinical situation, no attempt was made to control the speed or pressure of the polishing handpiece. Each finishing step was continued for a reasonable amount of time (less than 5 minutes for each sample) until the surface appeared smooth when viewed by the investigators under x5 magnifying glass. This approach to sample polishing was consistent with literature.[1011] Specimens were cleaned in an ultrasonic bath for 15 minutes using tap water. The surface roughness was measured using a surface roughness microanalyzer.t Three parallel scans, 2 mm apart, were made of each specimen using the parameter Ra (Ra = mean roughness = sum of elevations + depressions + sampling length). The cut-off value was 0.8 mm with a traverse length of 4.90 mm and a drive speed of 0.25 mm/sec. Two specimens from each group were viewed under a SEMtt and photographed at a magnification of X1500.

Results

The mean roughness, standard error of mean and 95% confidence interval for each of the autoglazed (AG), the liquid glazed (LG), the Shofu polished (SH), the Vident polished (VV), and the industrial glass polishing paste (GS) specimens are shown in Table 1. The table shows that the lowest mean roughness was that of the autoglazed porcelain. The mean roughness obtained as a result of using the Shofu and Vident pastes were equal to each other and quite close to that of the industrial glass polish. The latter three polishing materials resulted in a surface that has a higher mean roughness than that obtained by autoglazing but much smoother than that obtained from a liquid glazed surface.

One way analysis of a variance {ANOVA} (Table 2) showed that significant differences exist between the five means. Multiple range analysis (Table 3) showed that there was no difference in surface roughness among four treatments and all of them were significantly different (P < .05) from the liquid glazed surface.

SEM examination revealed that the liquid glazed surface [Fig. 1] is much rougher than surfaces treated by the other four methods.

Table 1. *Mean roughness and confidence intervals for five treatments.*

Group	Treatment	Specimen Count	Mean Roughness	Standard Error (Internal)	95 % LSD Intervals for Mean
1	AG	5	.3000000	.0836660	.1495426 .4504574
2	LG	5	1.1200000	.1772005	.9695426 1.2704574
3	SH	5	.5000000	.0316228	.3495426 .6504574
4	W	5	.5000000	.0632456	.3495426 .6504574
5	GS	5	.4600000	.0927362	.3095426 .6104574
5	Totals	25	.5760000	.0456070	.5087134 .6432866

Table 2. *Results of one-way analysis of variance.*

Analysis of Variances					
Source of Variation	Sum of Squares	D. F.	Mean Square	F - ratio	Significance Level
Between groups	1.9856000	4	.4964000	9.546	.0002
Within groups	1.040000	20	.052000		
Total (Corrected)	3.0256000	24			

Table 3. *Multiple range analysis for surface roughness.*

Method: 95% LSD Intervals

Treatment	Count	Average	Homogenity +	
AG	5	.3000000	*	
LG	5	1.1200000		*
SH	5	.5000000	*	
W	5	.5000000	*	
GS	5	.4600000	*	

*Asterisks on top of each other indicate no significant difference.

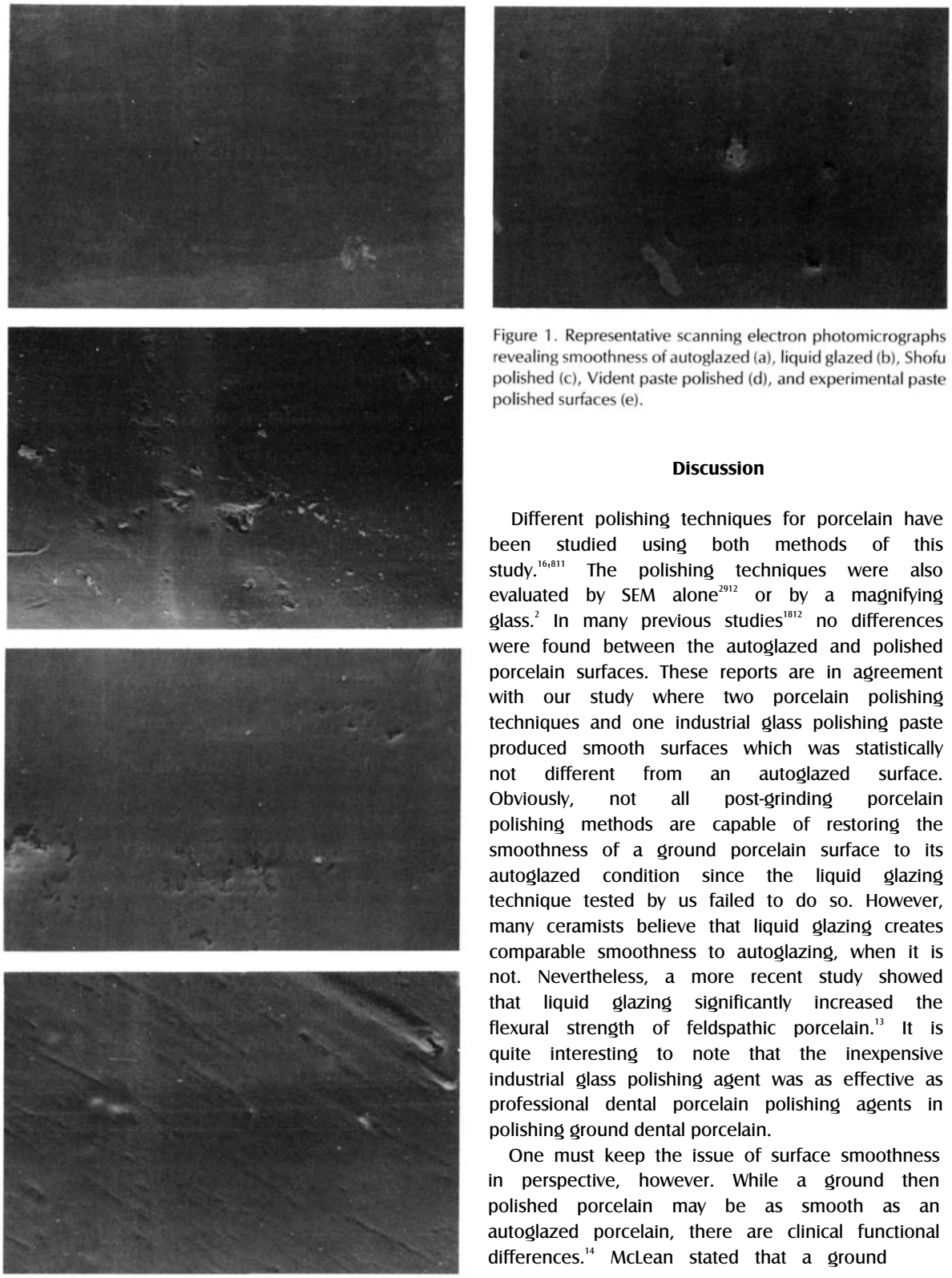

Figure 1. Representative scanning electron photomicrographs revealing smoothness of autoglazed (a), liquid glazed (b), Shofu polished (c), Vident paste polished (d), and experimental paste polished surfaces (e).

Discussion

Different polishing techniques for porcelain have been studied using both methods of this study.[16,8,11] The polishing techniques were also evaluated by SEM alone[2,9,12] or by a magnifying glass.[2] In many previous studies[1,8,12] no differences were found between the autoglazed and polished porcelain surfaces. These reports are in agreement with our study where two porcelain polishing techniques and one industrial glass polishing paste produced smooth surfaces which was statistically not different from an autoglazed surface. Obviously, not all post-grinding porcelain polishing methods are capable of restoring the smoothness of a ground porcelain surface to its autoglazed condition since the liquid glazing technique tested by us failed to do so. However, many ceramists believe that liquid glazing creates comparable smoothness to autoglazing, when it is not. Nevertheless, a more recent study showed that liquid glazing significantly increased the flexural strength of feldspathic porcelain.[13] It is quite interesting to note that the inexpensive industrial glass polishing agent was as effective as professional dental porcelain polishing agents in polishing ground dental porcelain.

One must keep the issue of surface smoothness in perspective, however. While a ground then polished porcelain may be as smooth as an autoglazed porcelain, there are clinical functional differences.[14] McLean stated that a ground

porcelain surface that is not reglazed will cause impairment of fracture resistance.[1516] However, McLean's methods of specimen preparation differed from the clinical situation. His specimens were hydraulically pressed from powder, the level of glaze used was higher than that used when matching the luster of natural teeth, and a medium-fusing porcelain rather than low-fusing metal ceramic porcelain was tested. In 1959, Hodson[17] reported that grinding glazed high- and medium-fusing porcelains reduced the modules of rapture but grinding low-fusing specimens did not. More recently in 1989, Rosensteil[10] found that the fracture toughness increased by using polishing as an alternative to autoglazing. Another study showed that fracture toughness increased by 22% when polishing was applied. In addition, the stainability was unaffected.[13] The author considered the results unexpected. Porcelain polishing is practiced more routinely especially after the introduction of porcelain veneers, inlays and onlays.[18]

It was further pointed out that an unglazed occlusal surface will cause more occlusal wear of opposing teeth than will a glazed surface.[3] It appears that good polishing ameliorates all negative effects of unglazing.

Conclusions

Based on the findings of this study, the authors conclude that:

1. An inexpensive industrial glass polishing agent was as effective as dental porcelain polishing agents in producing a smooth and glossy dental porcelain surface - be it an autoglazed or ground surface.
2. Liquid glazing may fill surface flaws but it was not as capable as mechanical polishing agents in restoring surface smoothness.
3. Even though ceramists polish their porcelain more routinely, fracture properties need to be further considered in future studies.

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