International Journal of Enhanced Research in Medicines & Dental Care
ISSN: 2349-1590, Vol. 2 Issue 12, December-2015

The effect of polishing on the surface of three different ceramic materials - A Sem Study

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Abstract

The use of ceramic materials in dentistry can be traced to 1728, when Fauchard suggested its use to restore teeth.. Glazed porcelain is the restorative material that least encourages plaque accumulation and plaque to be easily remove.The aim of glazing is to seal open pores on surface of fired porcelain

The adjustment of a porcelain restoration for occlusal or contour correction ,may have an unfavourable secondary impact on the neighboring teeth, depending on the location of the adjustment. The adjusted rough surface may lead to abrasive wear of the opposing dentition or increase the rate of plaque accumulation. Unglazed or trimmed porcelain may also lead to inflammation of the soft tissues it contacts. Trimming of porcelain may cause some reduction in the strength of a ceramic restoration.

Keywords: ceramics, polishing agent, SEM.

Polishing versus glazing

A number of more recent studies have suggested that a polished surface may be as acceptable as a glazed surface.many ceramists prefer polishing instead of glazing, to control the surface lusture. Rosentiel et al found that the fracture toughness of polished porcelain was greater than that of glazed porcelain and that both types of finish were equally resistant to staining by coffee.
The purpose of this study was to evaluate the effects of polishing techniques on the surfaces of three different dental ceramics. The hypothesis for this study was that the polishing techniques would have different effects on the surface roughness of dental ceramics.

Materials and methods

Materials used in study were:

1-Single bottle of IPS inline Transpaincisal 13, Ivoclar Vivadent, Liechnstein
2-Single bottle of Ceramco3, Dentsply, Germany
3-IPS E Max ingots ,Ivoclar Vivadent, Liechenstein
4-Shofu porcelain aadjustment kit ,Japan
5-Kohinoor L diamnds polishing paste, Renfert,Germany
5-Distilled water
6-Overglze ceramco3
8-Putty material, Aquasil Dentsply Germany

Equipments used were

1- SEM SU6600,E 1010 Gold Coating Unit, Htachi.
2-Surface roughness tester,SJ 301 Mitutoyo, Japan
3-Ceramic furnace, Multimat Mach 2 Dentsply, DETREY

ARMAMENTARRIUM USED-

AIR-rotor handpiece
Micromotor,
Midium grit diamond rotary cutting instrument,
Felt wheel,
Ultrasonic cleaner

IPS e.max is a lithium disilicate glass ceramic is a high strength ceramic material with 360-400 Mpa of flexural strength. When fabricated to full contour or in a monolithic state, Lithium disilicate is an extremely durable material
Ceramco3 natural enamels,

The Ceramco3 Natural Enamels are non-opalescent and can be used in thin or thick layers over the dentin to duplicate the vitality of natural teeth.

IPS Inline
Ips inline is a leucite- based ceramic system for the fabrication of metal ceramic restoration. It is having good esthetic, firing stability and low shrinkage.

Methods

Preparation of specimens -

The ceramic specimens of (ceramco3 Dentsply,IPS emax, IPSInline) were fabricated using a putty materials mold 10 mm in diameter and 3 mm thick. Each specimen was mixed using the same amount of ceramic powder and liquid and placed into the mold. The excess moisture was absorbed by using a tissue. After removal from the mold, the specimen were placed in a porcelain-firing oven (Multimat Mach 2) and fired according to the manufacture's instructions.

Firing temp	Overglaze temp(st)	Heat rate	High temp	Holding time
Ceramco 3				
940C°-960°C	600°C	50°C/min	930°C	1min
IPS Inline				
910°C	403°C	60°C/min	860°C	2min
IPS e.max				
750°C	403°C	60°C/min	725°C	1min

Thirty specimens of vacuum-fired ceramic were prepared. The specimens were made as uniformly as possible following manufacturer's directions. 30 specimens of different porcelain materials were grouped into group of 10 samples each. (Group A to C). Before deglazing procedure samples were marked with permanent marker to easily identify them.

Group A- Cermco3
Group B- Ivoclar IPS Inline
Group C- IPS E.MAX

One group at a time served as control group and had no surface treatment. Without deglazing procedure surface roughness of these specimens were evaluted using surface roughness tester (SJ 301 Mitutoyo, japan) to measure the roughness profile value in µm,the diamond stylus (10µm tip radius) was moved across the surface under a constant load of 4Mn and a speed of .25mm/s, this procedure was repeated 3 times at a different location for each specimen to obtain the general surface characteristics of the specimens. The average values of these measurements were considered to be the Ra values .

To evaluate the effect of the glaze on the ceramic surfaces of these control groups at a microscopic level, these groups were examined under field emission SEM(SU6600,E1010 Gold Coating Unit,Hitachi, Japan) at a 5.0 Kv at a working distance of 11.9 mm. The SEM photomicroghraphs were made with X 500 magnification for visual inspection.

In next step these groups were treated as experimental groups, and the glaze layer of each specimen was removed using a medium- grit diamond rotary cutting instrument (Shofu,Japan) with a slow –speed handpiece, with water cooling to simulate clinical procedure. Specimens were dried and then the surfaces of these groups were polished with adjustment kit (Sofu) with micromotor handpiece (Marathon-4 DAEGU,KOREA).The adjustment kit consisted of a 4-step process; a white stone and 3 different polishers were used, one at a time. The specimens were then ultrasonically cleaned (Branson 200 DANBURY CT, U.S.A.) with distilled water and dried with a blast of air, and again surface roughness value of specimen was measured with surface roughness tester. After polishing was completed, the sample with the best finish, as determined by visual inspection, was selected from each group for observation under SEM.

In 3rd step after polishing with adustment kit specimen's surfaces were polished with polishing paste (Kohinoor L, diamond polishing paste) with polishing wheel. The specimens were then ultrasonically cleaned. Surface roughness values were measured for each specimen and best polished sample was observed with SEM.

All polishing was done with techniques supplied, or recommended, by the manufacturer of each product. To simulate a clinical setting, no attempt was made to control the speed or pressure of the polishing handpiece. There was an attempt, however, to produce the best result possible in a reasonable amount of time(less than 5 minutes for each sample).
The Ra values were analyzed by ANOVA followed by a Bonferroni and Post Hoc Tests (α=,05).

Mean and standard deviation of materials

Table -1 Descriptives Average

	N	Mean	Std. deviation	Minimum	Maximum
F	**30**	**2.2643**	**.8313**	**.84**	**4.40**
IPS	**30**	**1.7288**	**.5120**	**.83**	**2.53**
L	**30**	**1.9424**	**.6640**	**.93**	**2.94**
	90	**1.9785**	**.7094**	**.83**	**4.40**

F-ceramco3, IPS emax,L- IPS Inline

Table-2: One way ANOVA

ANOV AVERAGE

	F	Sig
Between Groups	4.692	.012

Tables - 3: Multiple Comparisions

Dependent variable: AVERAGE
Bonferroni

(I)MATERIAL	(J)MATERIAL	MEAN Difference (I-J)	Sig
F	IPS	.5356	.009
	L	.3219	.213
IPS	F	-.5356	.009
	L	-.2137	.684
L	F	-.3219	.213
	IPS	.2137	.684

The mean difference is significance at the .05 level

Mean and Standard Deviation for Methods

Table 4: DESCRIPTIVE AVERAGE

	N	Mean	Std.Deviation	Minimum	Maximum
Glazed	30	1.2329	.3351	.83	2.29
Polish +Kit	30	2.2922	.5939	1.36	4.40
Kit only	30	2.4104	.4578	1.40	3.38
Total	90	1.9785	.7094	.83	4.40

Table -5 One Way ANOVA

ANOVA AVERAGE

	F	Sig
Between Groups	56.092	.000

Table-6 Multiple Comparisons of Methods

Post Hoc Test

Multiple Comparisons

Dependent Variable: AVERAGE Bonferroni

(I)METHODS	(J)METHODS	Mean difference (I-J)	Sig
Glazed	Polish+kit	-1.0593	.000
	Kit only	-1.1776	.000
Polish+kit	Glazed	1.0593	.000
	Kit only	-.1182	1.000
Kit only	Glazed	1.1776	.000
	Polish+Kit	.1182	1.000

The mean difference is significance at the .05 level

RESULTS

The mean Ra values for each Groups as follows:

Group -A 2.2643
Group-B 1.9424
Group -C 1.7288

Highest mean Ra value was observed for Group –A i.e 2.2643 and lowest was observed for Group –C i.e 1.7288.

Table -2 shows result of one way ANOVA for testing the P –value was .012 i.e < .05. this indicates that the mean values of all the groups have highly statistically significant difference.

Table -3 shows the multiple comparisons of Group-A, Group-B, Group-C. By using Bonferroni test, and there is statistically significant difference between the Ra value of Group-A with Group-C (P.009)

Table -4 shows the mean Ra values for each group with glaze surface, polished with kit only and polished with kit and paste.

Glaze surface 1.2329
Adjustment Kit +Paste 2.2922
Kit 2.4104

The lowest mean Ra value was observed for glaze surface i.e 1.2329.

Table -5 shows the result of one way ANOVA for testing . The P –value was .000 i.e <.05. this indicates that the mean values of all methods of polishing have highly statistically significant difference. Different methods give different surface roughness and in this study glaze gives lowest Ra values.

Table-6 shows the multiple comparisions of methods of polishing. It shows that there is statistically significant difference between Ra values of glaze surfaces and surface polished with other methods. Glaze creates more smooth surface than other methods.

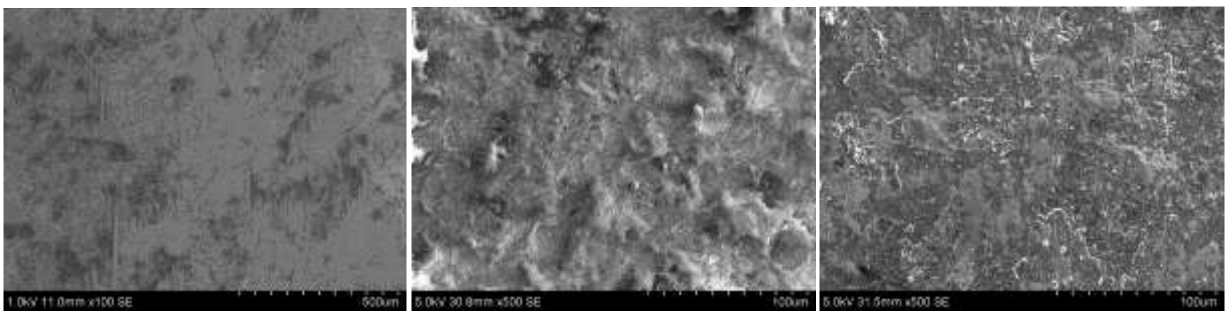
There is no significant difference between polished surfaces with adjustment Kit and Polishing paste.

SEM Photomicrograph

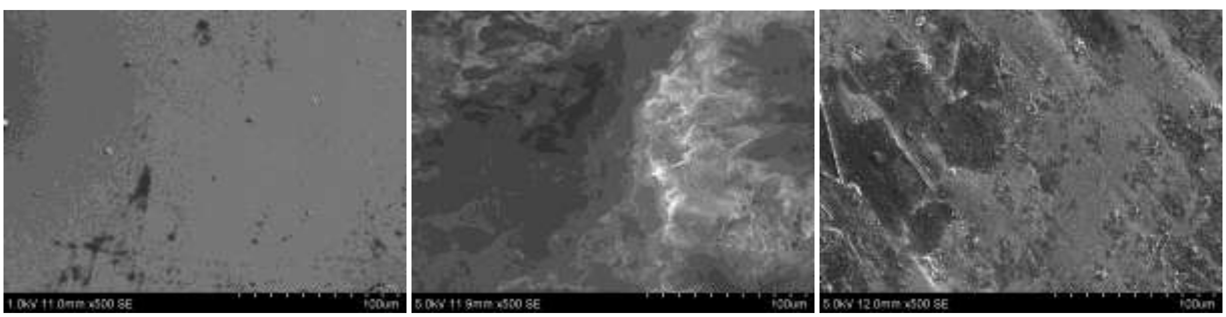
Group –A

Glazed surface | Adjustment Kit | Kit+Paste

Group-B



Group –C



When the SEM photomicrographs were examined ,it was observed that the use of adjustment kit and polishing paste appeared to create rougher surfaces than the surface obtained with glaze.

The result can be summarized as-

1-Group-A is more rough than other groups.
2-Glaze creates more smooth surface than other methods of polishing.
3-SEM- photomicrographs shows glaze surfaces are more smooth than others.

DISCUSSION

The present study was conducted to evaluate the in vitro effect of different polishing methods on three different ceramics. This study hypothesized that the different polshing methods give different surface roughness on different materials. In the persent study , the efficiency of two different polishing methods were compared with glaze on three different ceramics. These systems were selsected as being quick and efficient systems.

The result of this study indicates that the mean of surface roughness of glaze is 1.2329 and the mean of other polishing methods is 2.2922 and 2.4104. Glaze showed lower values of surface roughness, clinically also glazed surface was more smooth than other polishing methods. Surface smoothness in final polishing is obtained best if porcelain surface is grinded with yellow band diamond rotary instrument. Coarser abrasive give rise to rougher porcelain surfaces. On the basis of SEM examination, oven glazing was found to produce a better surface than the other polishing methods. Not all porcelain polishing systems produce a surface comparable to oven-glazed porcelain, and porcelain polishing systems should be chosen carefully.

The efficiency of porcelain polishing was found to be improved when diamond instruments were used at moderate speed, with water spray, or when carbide instruments were used at high speed, without spray.

It is likely that substrate properties such as modulus, surface hardness, grain size, and polishing method affect surface roughness. The 3 ceramic substrates had different composition and firing temperatures, despite being used for similar restorative purposes. The polishing method produced a pitted porous surface for ceramco3. Grain or crystal size, glass and/ or leucite content may have played a role in obtaining a smooth surface.

The SEM analysis of all ceramic substrates revealed increased porosity of the polished surface when compared with glazed surfaces. Polished ceramco3 exhibited relatively more porosity than IPS inline or IPS Emax. Pores are inevitable, and on removal of the glaze, the pores that are inherently present within the porcelain due to the manufacturing technique will open –up, resulting in rough surfaces.

The abrasive particles of the white stone in the adjustment kit are hard enough to remove the irregularities from the ceramic surface but could not produce smooth surfaces as glaze surfaces. It is possible that other combination of polishing methods using these polishing materials may produce better finishes than those obtained in this study.
Thus within the limitation of this study it can be concluded that glaze created more smooth surface. Group –A showed more surface roughness than Group-B and Group –C.

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