# Comparison the Surface Roughness of Polishing And Glazed Ceramic With Glazed Zirconium Based Ceramic

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**Abstract**

Porcelain veneer restoration often require modification at laboratory and chair side prior to cementation .Common adjustments include contour, occlusion , color correction , and special characterization masking of imperfections and final glazing.

The purpose of this study to compare surface roughness of polished, glazed porcelain with ceramic based zirconium.

Thirty samples {Twenty porcelain specimens resembling flat-back facing (Metal porcelain buttons) of vita ceramic and ten specimens of ceramic based zirconium } were fabricated according to the manufacturer's Instructions.(prepared with dimension of (10mm) in diameter and (2mm) in thickness).

The specimens were divided into three groups according to the type of surface treatment tested .Each group consisted of ten specimens and the groups were distributed as follows:-

- Group A: Polished unglazed porcelain with Rubber wheel.
- Group B: Glazed ceramic based Metal.
- Group C: Glazed ceramic based with zirconium.

The surface roughness evaluation of the specimens was carried out by a surface roughness analyzer device (profilometer).

Statistical analysis of data using (ANOVA- one way test) indicated high significant differences among the tested groups.

The highest roughness value was scored by group A (porcelain polished with rubber wheel ) followed by group B ( glazed ceramic based Metal.) then group C ( glazed ceramic based zirconium).

- Group (A) showed statistical significance in comparism to group (B).
- Group (A) showed high statistical significance in comparism to group(C)
-Group (B) showed statistical significance in comparism to group(C).

According to the conditions under which this study was carried out, it may be concluded that mechanical finishing, polishing procedures were not able to provided a surface as smooth as the glazed surface for the tested porcelain.

## Introduction

Dental porcelain have been modified to a state of near-perfection but still they exhibit ceramic disadvantages .The most serious is their tendency to abrade all structures against which it occludes including natural teeth and various type of non-porcelain restorative systems (**Lein felder , 2001**) .

In addition to the improved esthetic properties, such as translucency, color and intensity , the main advantages of dental porcelain materials are excellent biocompatibility and durability. (**Anusavice, 1996**). With the increase in the crystalline content of dental ceramics and increase in their mechanical properties, it has become possible to use them more safely in oral rehabilitation( **Scottt al 1995**).Alumina /zirconia-reinforced ceramics can be indicated for fabrication of fixed prosthodontics and implant abutments ,as alternative or substitute to the metallic framework( **Ardelin Bi2002**)

Dental ceramics and the high crystalline content ceramic framework of metal-free bonded prosthesis and implant abutment is often exposed to the oral environment. In these cases, the framework ceramic surface should be as smooth as possible, with the aim of minimizing the bacterial colonization and dental biofilm formation (**Rimondini et al 2002**). Grinding and polishing procedures to adjust ceramic restorations may also produce a rougher surface which may cause an increased rate of biofilm accumulation , producing gingival inflammation and adverse soft tissue reaction (**Rimondini etal 2002**). In addition, the occlusal adjustments may cause wear of the opposing teeth and also impair the strength of the ceramic restorations(**Fiscer et al 2003**).

Surface roughness refers to the finer irrigularities to the surface texture that usually result from the action of the production process or material condition and is measured in micrometers.Generally ,a smooth surface is desirable to reduce retention of bacteria and to have a shiny appearance (**Craig et al, 2004**).

This study aimed to compare the surface roughness of polished and glazed ceramic based metal with glazed ceramic based zirconium.

## Material &Methods

In the present study thirty samples (twenty porcelain specimens resembling flat – back facing metal porcelain buttons) of vita ceramic and Ten specimens of zirconium based ceramic ) are fabricated according to the manufactures .In fabrication of porcelain specimens, a sheet of modeling base plate wax 2 mm in thickness was punched with copper ring ( 10 mm in diameter )

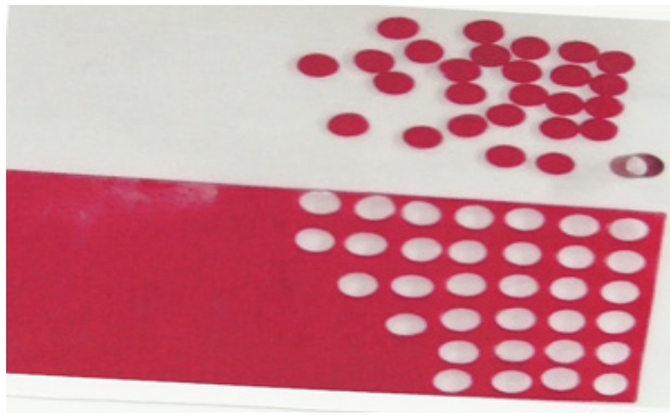

Figure 1

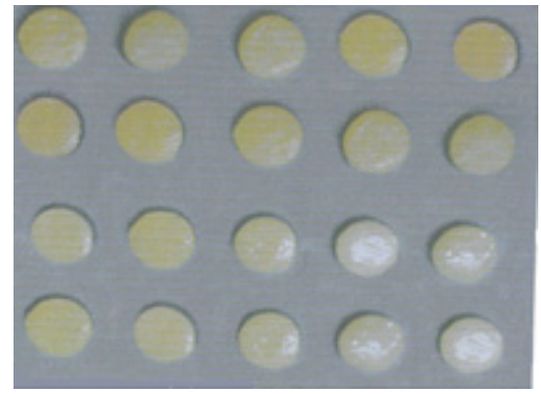

Figure (2) Metal ceramic sample

Spruing and investing of the specimens using phosphate bonded investment .burn out furnace used for burn out then casting using nichel-cromium ceramco alloy (super bond American Dent). Finishing of the metal disc done For standardization of a flat metal surface, to receive porcelain build up, each sample was sand papered (220 grit) manually at (1 cycle / sec.) For 50 sec. (**Zakaria and Al Na'ami, 2002**). Finally each sample was rechecked at three points (one in the middle and two in the periphery) for it's thickness which was about 2mm.

All samples was oxidized and Opaque porcelain was applied according to the manufactures instructions , dentin and enamel layer were applied by using bristle dental brush and baked together After complete porcelain buildup , the surface of porcelain was brought to a fine finish prior to glazing or polishing by using diamond finishing disc . (Rosensteil et al ., 1995 ) . The final thickness of each specimen ( porcelain + metal) was ( 4.0 mm +_ 0.5 ) and was standardized using a micro meter at 5 points reading for each sample . The Sample of Zirconium Ceramic are fabricated according to the manufactures instruction Using Manual coping milling machine, preparing frameworks for veneering , the stabilizer bars with diamond disc , smoothing the surface with zirconium dioxide stones blast structure with aluminum oxide.

The samples were divided into three groups, each having ten samples, follow:

**Group A: porcelain polished with Rubber wheels**. All samples were sand papered with straight hand piece at 35.000rpm speed (one disc \ each sample) then treated with ceramic

**II:** Samples were subjected to applied glaze by bristle dental brush technique and then subjected to a temperature of 900 ˚C in the computerized porcelain furnace (without vacuum), with a holding time of one minute without vacuum rubber wheel at the same speed using one rubber wheel for each sample.

**Group B:** Samples were subjected to applied glaze by bristle dental brush technique and then subjected to a temperature of 900˚C in computerized porcelain furnace (without vacuum), with a holding time of one minute without vacuum.

**Group C:** Zirconium samples with applied glaze. Figure (3)

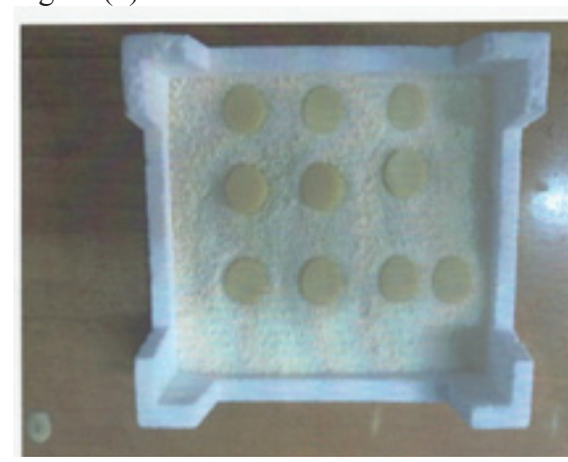

Figure (3)

The samples, after polishing were cleaned with distilled water for 5 min. then dried before profilometric testing.

A surface roughness tester device was used to verify the surface

topography of the polished samples and the glazed one .For each specimen, three readings were recorded (first reading in vertical line, second reading in horizontal line and third reading radial line "slop line")

The mean value was calculated. Surface profiles of the specimens that represent means of scores for all groups were recorded and analyzed.

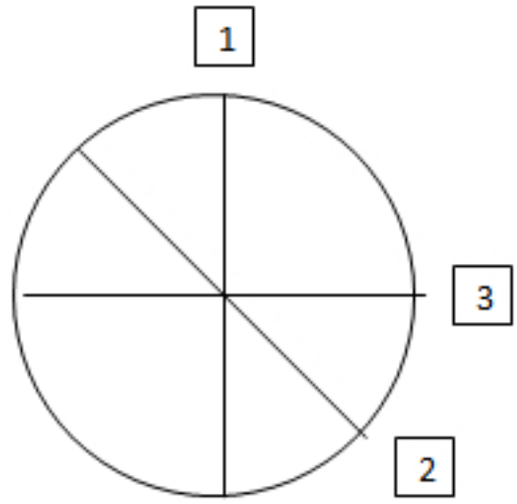


**Fig ( 4 )** profilometric reading pattern for each specimen

**Table 1:** Calibration (Methodology)

| | Surface roughness first reading | Surface roughness second reading (n=10) | Differences between first and second reading (n=10) | P (paired t test) |
|---|---|---|---|---|
| Group A | | | | |
| Range<br>SE<br>Coefficient of variation % | (0.268 to 0.873)<br>0.463±0.185<br>0.0586 | (0.244 to 0.831)<br>0.436± 0.183<br>0.0579 | (0.197 to 0.059 )<br>-0.027 ± 0.077<br>0.0243<br>16.6% | 0.29 (NS) |
| Group B | | | | |
| Range<br>SE<br>Coeffiecient of variation % | (0.055 to 0.594)<br>0.244 ± 0.169 | (0.059 to 0.591)<br>0.24 ±0.167 | (0.013 to 0.009)<br>-0.004 ± 0.007<br>2.9% | 0.14 (NS) |
| Group C | | | | |
| Range<br>SE<br>Coeffiecient of variation % | (0.134 to 0.283)<br>0.177 ± 0.048<br>0.0152 | (0.131 to 0.258)<br>0.175 ± 0.041<br>0.013 | (0.025to 0.012)<br>-0.003 ± 0.012<br>0.0038<br>6.8% | 0.49 (NS) |

There was a small and statistically in significant mean difference in SR. between first and second reading of the same equipment in the same spot in any of the 3 test materials.

The magnitude of errors committed by equipment were random and small ranging between 2.9 to 16.6 of the mean first reading SR.

## Results

### Surface roughness test results:

Results of surface roughness test in ( µm ) were obtained for( 30 )specimens in three Groups which include ( 10 )specimens in each Group that were tested after different surface treatment .

**Group A:** represent polished unglazed porcelain with rubber wheel.

**Group B:** represent glazed metal based ceramic.

**Group C:** represent glazed zirconium based ceramic.

**Descriptive statistics:**

The descriptive statistics of the difference in Ra values of the three Groups including arithmetic mean ,standard deviation ,standard errors ,maximum and minimum of the samples after different surface treatment are shown in Table .Graphical presentation by bar chart shown the means of difference in (Ra)values of the three groups are shown in Figure

**Table (2):**Descriptive statistic roughness among tested groups

| Groups | No. | mean | S.D | S.E | Range | |
|---|---|---|---|---|---|---|
| | | | | | Max | Min |
| Group A | 10 | 0.492 | 0.133 | 0.042 | 0.782 | 0.365 |
| Group B | 10 | 0.322 | 0.139 | 0.044 | 0.501 | 0.148 |
| Group C | 10 | 0.223 | 0.083 | 0.026 | 0.458 | 0.184 |
| Total | 30 | 0.340 | 0.1605 | 0.029 | 0.782 | 0.148 |

No. : Number
S.D : Standard Deviation
S.E : Standard error
Max: Maximum value
Min: Minimum value

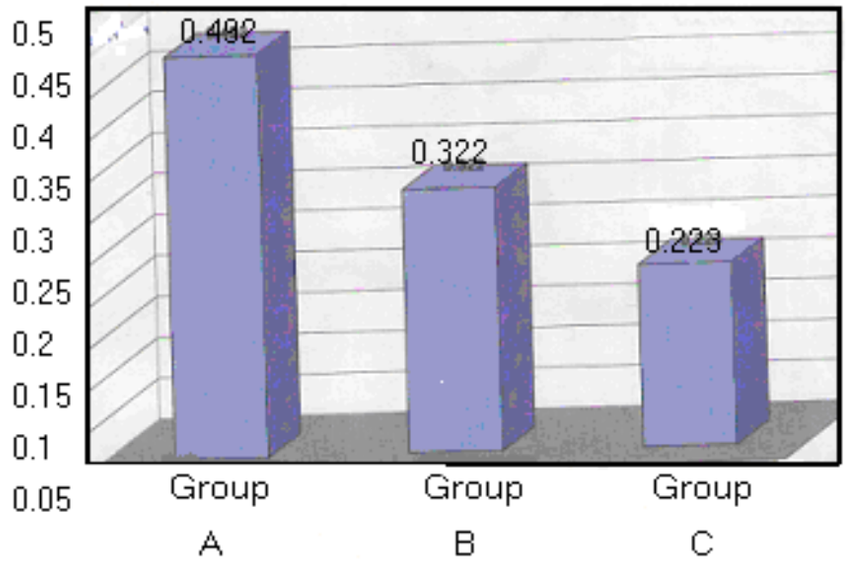


**Fig (4-1)** Graphical presentation by bar chart showing the means of differences in (Ra) values of the three Groups .

In general the highest mean score of Ra values were recorded in Group **A**b( 0.492)which represented the roughest surface followed by Group **B** then Group **C** . Group C showed the lowest mean score of Ra values (0.223) and thus the smoothest surface of porcelain.

**Inferential statistics :**

Statistical analysis of data by using analysis of variance (ANOVA) revealed that there was statistically highly significant difference among the three Groups at level $P < 0.01$ as shown in table (3).

**Table (3)** Analysis of variance (ANOVA) of three Group

| Anova | Sum of Squares | D.F | Mean of squares | F value | Sig |
|---|---|---|---|---|---|
| Between Groups | 1430 | 8 | 0179 | 0.008 | P<0.01 HS |
| Within Groups | 5361 | 18 | 0298 | | |
| Total | 6790 | 26 | | | |

Least significant difference test (LSD) was performed to compare the pairs of means that gave when comparison done between (Group A and Group B) P value 0.028 that mean $p<0.05$ (significant )and when comparison is done between (Group A and Group C) $p<0.01$ (high significant) and when comparison between (Group B and Group C) P<0.05 (Significant).

**Table (4)**

| | P-value | Sig. |
|---|---|---|
| Group A & Group B | 0.028 | P<0.05<br>S |
| Group A& Group C | 0.000 | P<0.01<br>HS |
| Group B& Group C | 0.046 | P<0.05<br>S |

**Table ( ) :** The last significant difference (L.S.D)of multiple comparison tests for surface roughness among tested Groups

S: Significant
HS: High significant

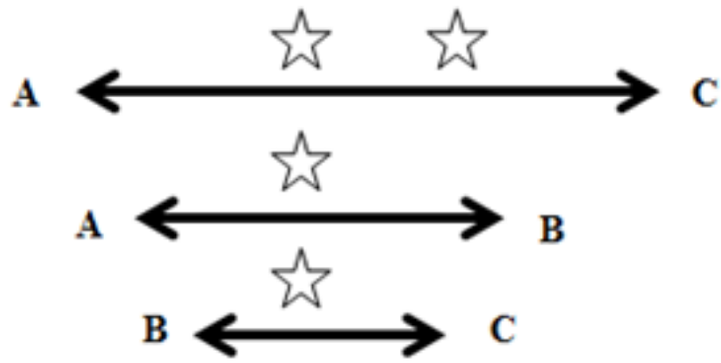


**Fig (4-1)** Graphical presentation by bar chart showing the means of differences in (Ra) values of the three Groups .

LSD test between Groups

## Discussion

Surface finishing is a critical step in achieving an esthetical acceptable restoration, and different materials and instruments may be used (**Patel SB et al., 2004**). Finishing refers to gross contouring or reducing of the restoration to obtain the desired anatomy, while polishing reduces the roughness and scratches created by finishing instruments. Rough poorly polished surfaces contribute to staining, plaque accumulation, gingival irritation .While dental porcelains have been modified to a state of near perfection, they also have a number of decided flaws because of the in homogenous distribution of crystals in a glassy matrix (**Oh et al., 2002**).

If the exposed porcelain surface is not a adequately polished, the ground surface may lead to accelerated abrasive wear of the opposing dentition.

In creased plaque accumulation, and reduced strength of the ceramic restoration (**Anusavice, 1996**) .It is not worthy to verify that a significant correlation was found between the roughness of porcelain surface and the biaxial strength being that the lees roughness the surface, the stronger the sample (**De Jager et al .,2000**).Scanning electron microscopy studies revealed that the initial adhesion of microorganisms beings in irregularities and is subsequently extended to the entire surface(**Nyvad B,Fejerskow O,1987**). Thus, the surface roughness of materials increases both the bacterial adhesion and faster maturation of the biofilm formed, which presents clinical implication, since this biofilm may present more pathogenic micro organisms.The hypothesis set as the premise of this study was accepted, since different technique for surface treatment affected the surface roughness of the evaluated dental porcelain. The Ra parameter obtained with a profilmeter is used to describe the surface texture of the porcelain specimens .This pa-

rameter describes the over all roughness of surface and can be defined as the arithmetical average value of all absolute distance of the roughness profile from the center line within the measuring length.(**Whitehead SA et al.,1995**). According to the results of present profilometer study of specimens showing that the (Group **A**)polished unglazed porcelain with rubber wheel is the roughest among the others Groups .Followed by (Group **B**) glazed metal based ceramic then (Group **C**) glazed zirconium based ceramic .The present study showed that there was significant difference between(Group **A** and Group **B**) and also significant difference between (Group **B** and Group **C**) but there was high significant difference between (Group **A** and Group **C**).

In Group **A** ( polished unglazed porcelain with rubber wheel ).

In this study we used one polishing technique (Rubber wheel ) according to some previous studies that shown all finishing and polishing technique resulted in a similar surface roughness(**SarikayaI,2010**).

The Group **A** shown higher roughness surface among the other Groups. Porcelain rubber wheel may be led to exposure to large bubbles in the surface. Coarser abrasives give rise to rougher porcelain surface .

The differences of pressure and time applied by different practitioner during the polishing procedure .Roughness values of the polished Groups may have varied if the using other rotary instrument ,rough surface have great potential to bacterial adhesion and can be more capable of wearing the opposing teeth (**Jagger DC and Harrison ,1994; Rimondini et al.,2002; Butler CJ et al.,2004**).Various finishing and polishing techniques can use on porcelain surface to preserve its structural resistance and obtain clinically acceptable smoothness comparing with glazing( **Patterson et al,1992; Wring, e t al. ,2004**).

In this study we agree with some studies that showed all finishing and polishing systems tested not provided surface roughness similar to the glazed surface. The polished surface were four times rougher than the glazed specimens of porcelain .This finding is in agreement with previous reports on the effect of different polishing technique on the surface roughness of several dental ceramic .(**Campbell ,1989 ;EI-Karaksi ,et al.,1993;Nishioka RS et al.,1999**). This study disagree with Sulik and Plekavich,1981;Bassing and Wiktorsson ,1982; AL Hadithy,2004 who demonstrates that no difference clinically or by mean SEM between the polished and glazed surface of porcelain ,and some voids are present on the polished surface which are not evident on the glaze. Also we disagree with (**Haywood et al,1988; Zakaria and AL-Na'ami , 2002**) .who found no significant difference could be observed in the quality and surface texture of polished and glaze porcelain.

And stated that final glaze presents the most acceptable surface, and found as a finer abrasive are used followed by adding glaze smoother and more regular. We disagree with previous studies on surface roughness of dental porcelains demonstrated that very smooth surface were obtain when restorations were polished with rubber wheel .(**Camacho GB et al,2006;Sara CD et al.,2006,Wright MD et al.,2004**).

We disagree with the result of (**Scurria and Power,1994** ) who concluded that feldspathic porcelain could be polished smoother than glazed and with (**Raimondo et al.,1990**) who reported that two of the four polishing paste tested produced better surface roughness than oven glazing . Also, there was a disagreement with (**Ward et al.,1995 and Kawai et al.,2000**) results who concluded that polishing rendered a smoother porcelain surface than glazing and thus factors less plaque adhesion .

We disagree with A number of studies have been performed to verify finishing and polishing techniques that would create surfaces as smooth or smoother than glazed porcelain .Some researchers preferred polishing porcelain for greater control of surface luster than of glazed porcelain(**Rosenstiel et al.,1989**). Others found no significant difference between the glazed and polished surface (**Grieve et al., 1991**).

- in Group **B** glazed porcelain surface (Metal based ceramic )

The aim of glazing is to seal the open pores in the surface of a fired porcelain. Dental glazes are composed of colorless glass powder, applied to the fired crown surface , so as to produce a glossy surface (McleanJW,1974) Group B was lower roughness than Group **A.**

The cause for lower values of surface roughness due to that applied glaze lead to seal microscpic pitting present on the porcelain surface that produce a satisfactory surface for porcelain restoration related to (**Cornelis and Toursuke,1985,Rosentid,1987;Shi lling burg al., 1997Rosenst 2001,Zakaria and AL-Na'ami,2002)**.

The application of glazing material after grinding will eliminate various defects and flows from the treated porcelain surface causing increase in smoothness of the surface .These findings are in agreement with several previous reports investigation the effect of different polishing techniques on the surface roughness of porcelain .

In this study we agree with the works of (**Suli and plekavich ,1982 ;Klausner et al.,1982;Raimondo et al.,1990;Patterson et al.,1991**)

Who found that a glazed surface of porcelain restoration would be better than polished porcelain surfaces. Conversely we disagree with other studies have shown that polished ceramics produced surfaces that were as smooth as glazed ceramics, or provided smooth surface than glazing (**Haywood VB et al.,1988;SaraCD et al.,2006;WerneckRD and Neisser MP,2008**).

Some explanation for these finding are the differences of experimental designs, dental ceramics and polishing method .Never the less ,these results suggest that surface roughness may be dependent on the combination of ceramic and polishing technique .Investigation of the glazed porcelain surface by **Jaggre** and **Harrison,1994** who showing that the glaze is removed in less than two hours of wear of glazed porcelain surface on a machine designed to simulate the masticatory cycle .They concluded that the amount of enamel wear produced by both glazed and unglazed porcelain is similar, with that polished porcelain is substantially less.

-In (Group **C** )The differences with relationship to the surface roughness observed among the ceramic can be ,probably ,attributed to the micro structural characteristic of the materials as size and it forms of the crystals .The manufacturers of the ceramic VM9 Comment that its microstructure presents more homogeneous distribution of the vitreous phases ,consequently less roughness surfaces are obtained, presenting high resistance to the biofilm formation when compared to the Conventional ceramic However the VM9 ceramic Group **C** showed the lowest mean Ra . value probably due to its finer microstructure and also the conditions of firing and sintering process that effect on porcelain surface.

Possible explanation for this disparity was different polishing rubber wheel and different surface textures of porcelain. (**Kantoriski KZ,2006**)

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