

# Does Surface Finishing Method Can Alter the Colour of Monolithic Zirconia Restoration?

## SUMMARY

*Monolithic zirconia restorations offer superior mechanic properties and improve indication of non-metallic restorations. Monolithic restorations eliminate bonding and chipping problems mostly seen in zirconia restorations. However, optical properties are insufficient. Colouring or staining is offer possibility to mask the opaque view of restoration. Polishing and glazing are also surface treatment methods for monolithic zirconia.*

*In this study effect of surface treatment methods on final view of zirconia were evaluated. For this purpose 30 monolithic zirconia samples (inCoris TZI, Sirona, Bensheim, Germany) were prepared. The samples were divided into 3 groups: In group A (n=10), glazing was performed using Vita Glaze (Vita Zahnfabrik, Bad Saeckingen, Germany); In group B (n=10), polishing was performed by using Soflex polishing system (3M-ESPE, Neuss, Germany); in Group C (n=10), polishing and glazing were performed. Before and after the applied the surface treatment methods, colour measurements were performed with a spectrophotometer (Vita EasyShade Advanced, Vita Zahnfabrik, Bad Saeckingen, Germany). Data were analysed using paired sample t-test at the  $p \leq 0.05$  level and one-way analysis of variance (ANOVA) combined with Tukey's multiple comparison tests.*

*In all groups there were alterations in colour values; however,  $\Delta E < 3.7$  and the colour changes were undetectable.*

**Keywords:** Monolithic Zirconia, Polishing, Glazing

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**ORIGINAL PAPER (OP)**

**Balk J Dent Med, 2015; 19:128-131**

## Introduction

Zirconia is widely used for manufacturing dental restorations due to its superior mechanical strength, toughness, and young modulus. Beside these suitable properties, chemical stability makes zirconia mostly preferred prosthetic restoration material. Good mechanical properties of zirconia can be explained by the transformation toughening mechanism. It is a change of crystal structure (tetragonal to monoclinic) under stress area. Tetragonal crystals are tightly packed and spaces between these crystals are fulfilled with yttrium oxide molecules that compact the tetragonal geometry of crystals. When a crack occurs and propagates, this compact structure loosens in crack related areas. Because of decreased pressure on tetragonal crystals geometry, transformation to monoclinic crystal geometry occurs. After that transformation, volume increases in concerned

area. This volume increment around the crack area creates compressive forces and stops the crack propagation<sup>1-3</sup>.

Zirconia was used with veneering porcelain in order to mask the opaque view of this material. By the help of optic properties of veneering porcelain layer, layered zirconia restoration seems looking more natural. However fracture or chipping of veneering ceramics are most seen complication of zirconia supported ceramic restorations<sup>4-6</sup>. To overcome this complication full-contour (monolithic) zirconia was introduced. This type of restoration consists of only zirconia, there is no porcelain veneering layer. The advantage of monolayer restoration is relatively reduced thickness of ceramic restorative material. Additionally, its easy and rapid manufacture with computer-aided design/computer-aided manufacturing (CAD/CAM) systems increased the use of monolithic zirconia reconstructions<sup>7</sup>.

In order to achieve natural look restorations, monolithic zirconia can be shaded before sintering process,

surface characterizations, glazing or polishing can be applied. Surface gloss or lustre is one of the properties that determine the final appearance of the restoration with the shape and transparency. However it is still big challenge to reach satisfied aesthetic result since they are monolayer restoration. Polishing procedure gives a lustre to the surface of monolithic zirconia restoration; it consists of using rubber wheels and abrasive pastes. In glazing procedure, glaze material is applied on restoration and fired to get glaze layer restoration. Conventional dental porcelain's surface gloss could be obtained by glazing procedure.

Although, there have been a lot of studies reporting surface finishing methods in terms of evaluation of 2 body wear performance, studies that investigate the effect of surface finishing method on final colour of monolithic zirconia restoration are limited. Therefore the aim of this study was to evaluate the effect of surface finishing methods on colour stability of monolithic zirconia restoration. The hypothesis to be tested was that their surface finishing methods have no effect on colour stability of monolithic zirconia restoration

## Materials and Methods

Highly translucent zirconium oxide blocks for full contour crowns and bridges (inCoris TZI, Sirona, Bensheim, Germany) were sliced by using a slow-speed diamond saw (Isomet wafering blades, Buehler, IL, USA) and a precise cutting machine (Isomet 1000, Buehler, IL, USA). The chemical composition and physical properties of inCoris TZI were shown in tables 1 and 2. The slices of 1.6 mm thick and all slices were measured with a digital calliper (Mitutoyo Manufacturing Company Ltd, Kawasaki, Japan) to achieve same thicknesses. Edges of the samples were rounded.

Table 1. Chemical composition of inCoris TZI

Component	inCoris TZI
ZrO <sub>2</sub> +HfO <sub>2</sub> +Y <sub>2</sub> O <sub>3</sub>	≥ 99.9%
Y <sub>2</sub> O <sub>3</sub>	5.4%
Al <sub>2</sub> O <sub>3</sub>	≤ 0.35%
Fe <sub>2</sub> O <sub>3</sub>	≤ 0.01%
Other oxides	≤ 0.2%

Table 2. Physical properties of inCoris TZI

Density	6.08 g cm <sup>-3</sup>
Fracture toughness KIC	6.4 MPa m <sup>1/2</sup>
Thermal expansion coefficient (20 - 500 °C)	10.4 10 <sup>-6</sup> K <sup>-1</sup>
Bending strength	> 900 MPa

Specimens were sintered in a sintering furnace (inFire HTC, Sirona, Bensheim, Germany). After sinterization, the shrinkage of specimens was about 20%. The grinding was performed at both side of each specimen to achieve 1.2 mm final thickness with silicone carbide papers by using the grinding machine (Forcipol, Metkon, Bursa, Turkey). Thickness of the samples was measured as 12 + 0.05 mm with a digital calliper (Mitutoyo Manufacturing Company Ltd, Kawasaki, Japan).

The samples were divided into 3 groups of 10 samples each. In Group A (n=10), glazing was performed using Vita Glaze (Vita Zahnfabrik, Germany) porcelain furnace (Programat P 300, Ivoclar/Vivadent, Liechtenstein); in Group B (n=10), polishing was performed by using Soflex polishing system (3M ESPE, USA); in Group C (n=10), both polishing and glazing were performed.

Before and after applying a surface finishing method, colour measurements were carried out. All samples were ultrasonically cleaned in distilled water for 3 min and then dried before measurements.

Colours were measured according to Commission Internationale de l'Eclairage (CIE) 1976 L a\*b\* colour space (CIELAB) with contact type spectrophotometer (Vita EasyShade Advanced, Vita Zahnfabrik, Bad Saeckingen, Germany). Calibrations were made before starting colour measurement in each group. L, a\* and b\* values were used to evaluate colour difference, ΔE of groups were calculated by using the following equation

$$\Delta E = [(L_1 - L_2)^2 + (a_1^* - a_2^*)^2 + (b_1^* - b_2^*)^2]^{1/2}$$

where the L\* represented the brightness, the a\* value represented the red-green chromatics, and the b\* value represented the blue-yellow chromatics.

SPSS software (version 20.0, SPSS Inc., Chicago, IL, USA) was used for statistical analyses. The differences between before-after surface treatment methods were determined by using paired sample-t test at the p≤0.05 level. The differences L a\* b\* in values were determined by using one-way analysis of variance (ANOVA) with Tukey's multiple comparison tests.

## Results

A total 60 colour measurements was performed. Mean values of L, a\*, b\* and ΔE were shown at table 3. In all groups ΔE < 2.6 that clinically undetectable colour changes were examined. Beside this results in Group A glazing procedure caused a statistically difference in a\* value (p=0.024). Polishing, changes in b\* value were statistically significant. Glazing after polishing significantly changed the b\* value (p=0.016). Alteration of a\*,b\* value between Group A and B was not significant, where alteration of b\* was significant between all groups. L value didn't change in all groups.

Table 3. Mean values of L\*, a\*, b\* and ΔE

Group	L1	a1*	b1*	L2	a2*	b2*	ΔE
A	99.99	-0.97	6.78	100	-0.52	7.19	0.83
B	100	-1.16	6.6	100	-0.88	7.19	0.66
C	100	-1.32	6.31	100	-1.44	5.8	0.60

## Discussion

The hypothesis of this study was accepted because ΔE values of all groups were under 2.6. Surface finish method didn't affect the final colour of unstained zirconia. Douglas et al<sup>8</sup> reported that the detectable colour difference at which 50% of the dentist could perceive a colour difference was 2.6. But differences occur before and after colour measurements. It was examined that glazing and polishing degrees a\* value and makes final colour more reddish. However in Group C surface treatments improved the greenish. b\* values increased in Group A and B; polishing and glazing made samples more yellow. In Group C, b\* value was reduced.

Zirconia is a kind of polycrystalline ceramic, and because of its high crystalline content of zirconia, optical properties are insufficient. Crystalline structure affects the translucency of the materials. Zirconia particles are bigger than the wavelength of visible light. These dispersed particles throughout the matrix cause maximal scattering effect. As the scattering and reflectance of the light increases, the material will look more opaque<sup>9,10</sup>. Light transmittance and reflectance have important roles in the aesthetics of restorations<sup>11</sup>. The translucency of monolithic zirconia was improved but still unsatisfied when compared with translucency of natural teeth. Harianawala et al<sup>12</sup> compared light transmittance for different types of zirconia and lithium disilicate materials and concluded that translucent zirconia is significantly more translucent than conventional zirconia. However, it is significantly less than conventional lithium disilicate.

In conventional layered ceramic restoration final colour occurs from a diffuse reflectance of the dentin porcelain layer filtered by the scattering of outer enamel porcelain layer<sup>13</sup>. So, optical scattering and absorption are affected by optical properties of veneering material thickness and reflectance of the core materials. Surface finishing methods, regardless glazing, polishing or both polishing-glazing, could change the light interpretation.

Scurria et al<sup>14</sup>, reported that polishing on ceramic could be used for obtain lustre surfaces as an alternative method for glazing in ceramic restorations in terms of surface roughness. Mundhe et al<sup>15</sup> performed a clinical *in vivo* study to evaluate the wear of natural enamel opposite to polished monolithic zirconia and metal ceramic

crowns. They reported that polished Zirconia crowns led to less wear of antagonist enamel than metal ceramic crowns, but more than natural enamel.

In this study lightness of the samples didn't change; in contrast, Kim et al<sup>16</sup> reported that polishing reduces the lightness, and glazing also reduces the lightness. Kim also reported that polishing and glazing increase the yellowness of monolithic zirconia that matches the finding of this study.

In order to evaluate pure effect of surface finishing methods on final view of samples, non-stained monolithic samples were used. Different results could be reported in prefabricated stained zirconia. Further studies are needed to determine the effect of polishing and glazing procedure on the final colour of the stained monolithic zirconia restoration.

It is a big challenge to reach aesthetic and natural tooth colour with monolithic zirconia restorations because of its polycrystalline chemical composition. To achieve smoothness surface polishing and glazing are good surface treatment methods. Both of these methods can alter the final view of the restorations and practitioner should take into account the probability of colour change after glazing or polishing.

## Conclusion

Glazing, polishing, or polishing & glazing do not affect the final colour of non-stained monolithic zirconia.

Polishing and glazing make restoration more yellowish.

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