Color Masking Ability of Lithium Disilicate Crowns for Titanium Implant Abutments
An in-vitro analysis

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Introduction

Dental implants are clinically effective treatment choice for rehabilitation of lost or congenitally missing teeth for complete or partially edentate patients[1]. However, management with implants does not come without challenges, one of which is to achieve soft and hard tissue esthetics. Prefabricated Titanium (Ti) implants abutments are the most common choice due to its cost effectiveness. Nonetheless, esthetic has been a setback since Ti abutments produce grayish discoloration in the final restoration[2]. Zirconia (Zr) abutments introduced as an alternative compensating the esthetic drawback caused by Ti abutments. However, Zr abutment has higher mechanical complications compared to Ti abutments[3].

Porcelain restorations made a revolution in the esthetic dentistry. Light transmission and translucency of the porcelain restorative materials improved the production of a prosthesis which mimic the natural tooth appearance, with the production of several ceramic system with various properties and structure; Zr and lithium disilicate (LD) are the most utilized systems clinically[4]. Nevertheless, the underlying substrate either it was natural tooth, a core or implant abutment can alter the color of the final porcelain restorations as it has been proven in the literature[5].

Objective

- The aim of this study is to assess the ability of different thickness of monolithic LD ceramics in masking of Ti implant abutment by color matching.
- The objectives were to compare the effect of Ti and Zr abutment on the color of LD and Zr crowns.

Materials & Methods

An in-vitro experimental study with the following variables:

- Two implant abutments Ti (Straumann, ITI, 0°, MA, USA) and Zr (Straumann, ITI, Standard customized abutment, 0°, Basel, Switzerland) Fig 2.
- Fifty LD coping divided in 5 groups with different thicknesses; 1.0 mm (n=10), 1.2 mm (n=20), 1.5 mm (n=10), 1.8 mm (n=10) (Fig 4) surveying device to standardize the scanning process of the foundation substrate; Ti abutment and Zr abutment. CAD/CAM and Hot-pressing techniques were used for fabrication of Zr and LD copings respectively. All samples within groups were coded to avoid operator and evaluator bias. A translucent temporary cement (Temp Bond Clear) were used under standard load Fig 3. All copings were cemented on the implant abutments resulting in six groups Fig 1.

Each cemented specimen was placed in spectrophotometer (Crystaleye; Olympus, Tokyo, Japan) Fig 5. All measurement was taken according to the manufacture instructions, a resin jig was fabricated for reproducibility and standardization of position. The color difference was calculated using the three-dimensional color space (L*, a*, b*) using CIE Lab color space. A block of Zr (4x4x2mm) (Milled, MO, Cercon Base blank, DeguDent GmbH, Hanau-Wolfgang, Germany), and another LD block (4x4x4mm) (IPS e.max, Ivoclar Vivadent, AG, Schaan / Liechtenstein) were fabricated and measured by the spectrophotometer to use it as a control to calculate ΔE, by using the following formula:

$$\Delta E = [(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]^{1/2}$$

The means and standard deviations of ΔL, Δa and Δb were tabulated and means for ΔE among all groups were identified. These were statistically compared using analysis of variance and Tukey post hoc multiple comparisons. A p value of <0.05 was considered statistically significant.

Figure 1: Study Groups

Zr-Ti-0.5: Zirconia specimen of 0.5mm on Titanium abutment

LD-Ti-1.0: Lithium disilicate specimen of 1mm on Titanium abutment

LD-Ti-1.2: Lithium disilicate specimen of 1.2mm on Titanium abutment

LD-Ti-1.5: Lithium disilicate specimen of 1.5mm on Titanium abutment

LD-Ti-1.8: Lithium disilicate specimen of 1.8 mm on Titanium abutment

LD-Zr-1.2: Lithium disilicate specimen of 1.2 mm on Zirconia abutment

Fig 2: Ti implant abutment mounted on acrylic using surveying device.

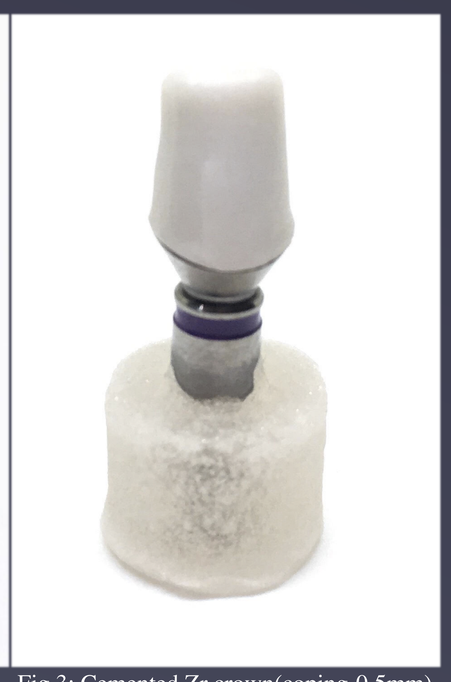


Fig 3: Cemented Zr crown(coping-0.5mm) on Ti implant abutment.

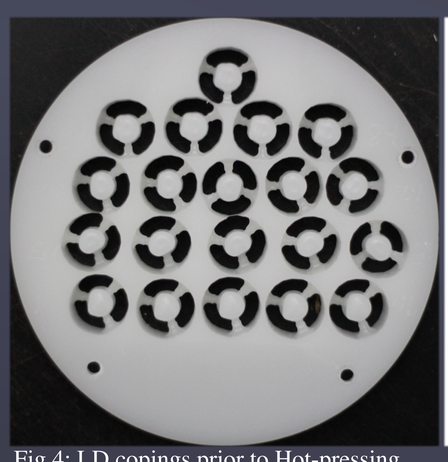


Fig 4: LD copings prior to Hot-pressing.

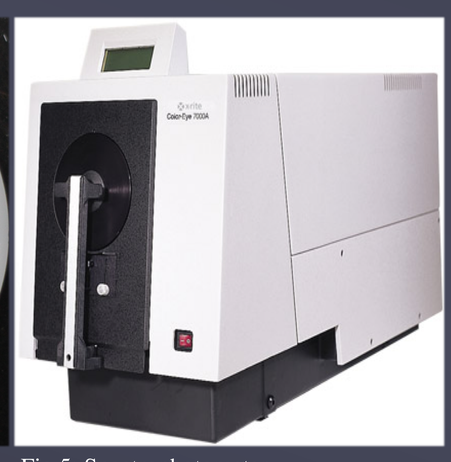


Fig 5: Spectrophotometer.

Table 1: Mean and standard deviations for CIELab values at 95% confidence interval.

Ceramic / Abutment/ (mm)	ΔL*	Δa*	Δb*
Zr-Ti- 0.5	-1.0 ((-0.4) – (-1.5))	-0.5 ((-0.1) – (-0.7)	-1.3 ((-0.2) – (-1.9))
LD-Ti-1.0	3.0 (3.2 – 2.8)	3.0 (3.1 – 2.9)	-2.6 ((-2.4) – (-2.7))
LD-Ti-1.2	2.0 (2.4 – 1.6)	1.0 (1.4 – 0.8)	-1.7 ((-1.5) – (-2.0))
LD-Ti-1.5	1.8 (2.1 – 1.0)	1.1 (2.0 – 0.2)	-1.6 ((-1.0) – (-2.0))
LD-Ti-1.8	1.3 (2.0 – 0.8)	1.3 (1.7 – 1.0)	-1.1 ((-0.9) – (-1.5))
LD-Zr-1.2	0.3 (0.7 – (-0.03))	0.8 (1.3 – (-0.5))	0.2 (0.6 – 0.1)

Ti: Titanium, Zr: Zirconia, mm: millimeter, LD: lithium disilicate SD: Standard deviation

Table 2: Mean and SD of ΔE (color difference) values among study groups

Abutment Material	Ceramic Crown Material					P value
	LD (mean ± SD)				Zr (mean ± SD)	
	1.0mm	1.2mm	1.5mm	1.8mm	0.5mm	
Ti	4.93 ± 0.45	2.89 ± 0.37	2.62 ± 0.48	2.3 ± 0.31	2.2 ± 0.33	<0.01*
Zr	-	1.39 ± 0.42	-	-	-	

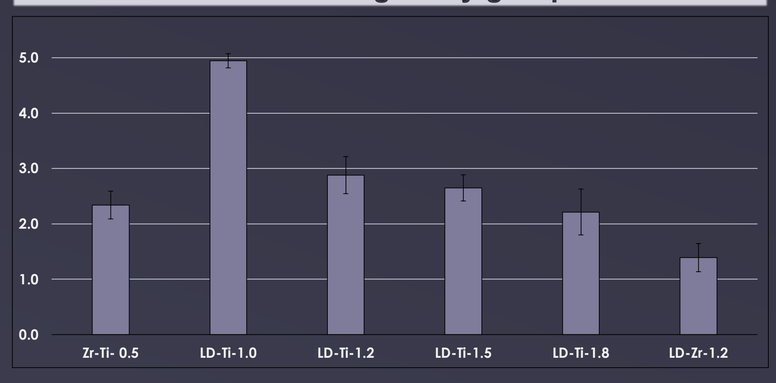
Ti: Titanium, Zr: Zirconia, mm: millimeter, SD: Standard deviation, *: statistically significant. Statistical comparison using ANOVA.

Table 3: Statistical comparison of ΔE among study groups using Tukey Post Hoc comparison.

Study groups	Mean difference	P value	Study groups	Mean difference	P value
LD-Ti-1.8 vs LD-Ti-1.0	2.590	<0.01*	LD-Ti-1.0: vs Zr-Ti-0.5	-2.720	<0.01*
LD-Ti-1.8 vs LD-Ti-1.2	-0.590	<0.019*	LD-Ti-1.0: vs LD-Zr-1.2	-3.540	<0.01*
LD-Ti-1.8 vs LD-Ti-1.5	0.2900	0.622ns	LD-Ti-1.2 vs LD-Ti-1.5	-0.270	0.655ns
LD-Ti-1.8 vs Zr-Ti-0.5	-0.130	0.980ns	LD-Ti-1.2 vs Zr-Ti-0.5	-0.690	<0.01*
LD-Ti-1.8 vs LD-Zr-1.2	-0.950	<0.01*	LD-Ti-1.2 vs LD-Zr-1.2	-1.500	<0.01*
LD-Ti-1.0: vs LD-Ti-1.2	2.040	<0.01*	LD-Ti-1.5 vs Zr-Ti-0.5	-0.420	0.220ns
LD-Ti-1.0: vs LD-Ti-1.5	-2.300	<0.01*	LD-Ti-1.5 vs LD-Zr-1.2	-1.240	<0.01*
Zr-Ti-0.5 vs LD-Zr-1.2	-0.820	<0.01*			

Ti: Titanium, Zr: Zirconia, mm: millimeter, LD; lithium Disilicate (Emax) SD: Standard deviation, *: statistically significant, ns: not significant.

Figure 6: Mean and SD of ΔE (color difference) values among study groups



Results

According to the three-dimensional color space “CIE Lab” the color difference of L*, a* and b* was calculated from the baseline. The mean and standard deviation of ΔL*, Δa* and Δb* are shown in table 1. ΔE was calculated by using CIE Lab formula, their mean and standard deviation are represented in table.2 and Fig.6 Whereas, table.3 represent a statistical comparison among the study groups.

Discussion

The present study was based on the hypothesis that the use of monolithic LD ceramics with different thickness will show clinically acceptable esthetic outcome and color matching when used with Ti abutments. The hypothesis was partly accepted since, 1.5 and 1.8mm LD on Ti abutment groups showed similar ΔE values;” 2.62 and 2.3 respectively” compared to 0.5mm Zr which has a ΔE of 2.2 on Ti abutment. In addition, 1.0 and 1.2mm LD revealed higher ΔE values;” 4.93 and 2.89 respectively” in the same observation. However, Zr abutment restored with 1.2mm LD has a ΔE of 1.39. According to the literature the clinical acceptable and visually perceptible color difference is ΔE < 2.25, yet others suggest that a ΔE< 3.7 could be undetected clinically.

Monolithic lithium disilicate ceramics was used in this study for its physical properties and its ability to produce a suitable aesthetic result without the need of using layering technique, color difference was measured by a single operator on specimens made on abutments of same dimensions, similar material (Ti and Zr) and single cement type, to minimize variations and comparison with other studies. Consequently, changing the thickness of the ceramic restoration was the main factor in determining the aesthetic result.

Within the limitations, we conclude that,

Conclusion

1. Masking ability of 1.5mm LD crowns was comparable to Zr crowns when placed on Ti implant abutments.
2. Zr abutment provided the most esthetic clinically acceptable outcome.
3. Increasing the thickness of LD ceramics, improves its masking ability of Ti abutments.
4. Use of opaque cements may further enhance the masking ability of LD ceramic restorations.

Reference

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Acknowledgment

The authors extend their appreciation to the Deanship of Scientific Research at King Saud University for funding this work through the Undergraduate Research Support Program , Project no usrp-3-17-29 .