

Optical Properties of Monolithic CAD/CAM Zirconia Reinforced Lithium-Silicate Crowns

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Abstract

Background: All-ceramic systems and CAD/CAM technics allow dentists to make monolithic glass-ceramic restorations with reduced wall thickness. The aim of this in vitro study was to determine how substrate colors, ceramic thickness and translucency, cement shades effect the final shade of CAD/CAM monolithic zirconia reinforced lithium-silicate crowns.

Methods: A premolar teeth (14) were prepared on a study model for 1.0 and 1.5-mm thick full ceramic monolithic crowns. Intraoral scanner was used (Trios, 3Shape) to create digital impressions. CAD/CAM technics were used to design crowns. Shade A1 crowns were milled (Everest, Kavvo) from HT (high translucency) and T (translucent) Vita Suprinity (Vita Zahnfabrik) blocks. 9 substrates were made of different color (Vita Simulate, zirconia, Co-Cr, gold-colored) and three different try-in pastes were used to simulate the color effects (Variolink Esthetic Try-In paste, Ivoclar). Shade measurement was done 3 times for each crown by spectrophotometer (Vita, Easyshade Advance) and averages were compared to a reference crown.

Results: All of the examined parameters influenced ΔE_{00} of the CAD/CAM monolithic crowns. The weakest effect was exerted by the color of the try-in paste. When ΔE value smaller than 1.8 is regarded as a clinically not acceptable color change, out of 108 measured combinations none of the HT and 19 of T crowns were below this threshold.

Conclusions: Before choosing the ceramic block translucency and restoration wall thickness we should consider the underlying abutment color, but final color was just barely affected by luting cement shade in case of 1.0 and 1.5 mm thick ceramic crowns.

Introduction

Matching the color of the natural dentition with the shade of ceramic crowns is a great challenge in dentistry. To meet patients' increasing esthetical needs, CAD/CAM methods are very popular for full ceramic crowns. When the right color block of glass-ceramic material is selected for the restoration it must be taken into consideration, that the final esthetics may be influenced by underlying tooth color due to their translucency and also affected by luting cement shade.^{1,2}

The aim of this in vitro study was to determine how different parameters: substrate colors, ceramic thickness and translucency, cement shades effect the final shade of CAD/CAM monolithic zirconia reinforced lithium-silicate (VITA Suprinity, VITA Zahnfabrik) crowns (Figure 1) produced by CAD/CAM technology based on intraoral scans (3shape TRIOS).



Figure 1: Vita Suprinity HT crown (14) with 1.5 mm buccal wall thickness on 5 different shaded substrates, cemented with neutral try-in paste



Figure 2: Chamfer preparation (14)

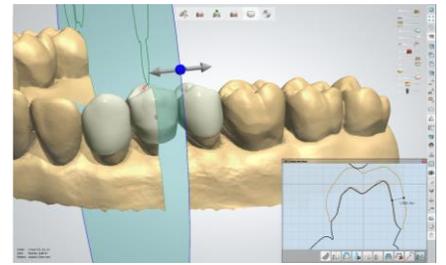


Figure 4: CAD design (Dental Designer)



Figure 5: Precrystallised VITA Suprinity crowns

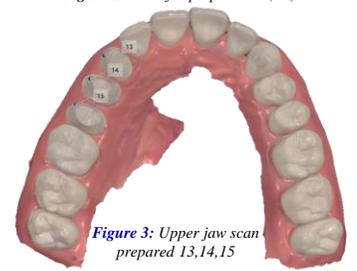


Figure 3: Upper jaw scan prepared 13,14,15

Materials & Methods

According to our previously published study protocol¹ premolar teeth (14) were prepared on a study model for 1.0 and 1.5-mm thick full ceramic monolithic crowns (Figure 2). Intraoral scanner was used (Trios, 3Shape) to create digital impressions (Figure 3). The digital impression of the original tooth shape was used to design the ceramic crowns. CAD/CAM technics were used to design (Dental Designer) and make crowns with identical shape and size (Figure 4) and cementation gap was set 0.04mm. Even thicknesses of 1.0 and 1.5 mm were secured on the buccal sides of the ceramic crowns. Shade A1 crowns were milled (Everest, Kavvo) from HT (high translucency) and T (translucent) Vita Suprinity (Vita Zahnfabrik) zirconia reinforced lithium-silicate blocks (Figure 5). 9 substrates were made of different color and materials (6 of Vita Simulate composite material and zirconia, Co-Cr, gold-colored alloy) to imitate substrate effects on the final shade. Three different try-in pastes (Light plus, Neutral, Warm) were used to simulate the color effect of cements (Variolink Esthetic Try-In paste, Ivoclar). Shade measurement was done 3 times for each crown by spectrophotometer³ (Vita, Easyshade Advance) and averages were compared to a reference crown (A1, 1.5mm, T, 2M3S abutment, neutral try-in paste). ΔE_{00} was calculated (CIEDE 2000 formula)⁴.

Results

All of the examined parameters influenced ΔE_{00} of the CAD/CAM monolithic crowns (Figure 6). Highest color difference was measured by 1 mm T crowns on Co-Cr substrates. When ΔE value smaller than 1.8 is regarded as a clinically not acceptable color change⁵, out of 108 measured combinations none of the HT and just 19 of T crowns were below this threshold. The weakest effect was exerted by the color of the try-in paste (Figure 7). In Figure 7, the Values in the negative range indicate better results having been achieved with a type of cement different from the neutral. It has a significant color changing affect when we applied light plus cement on Co-Cr substrates. In case of HT crowns ceramic thickness has more influence on the final shade compared to the T crowns (Figure 8).

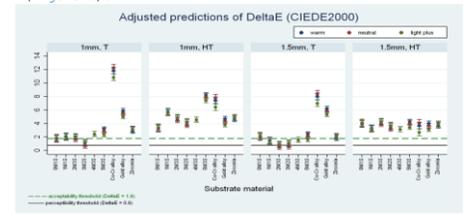


Figure 6: The measurement results grouped by crown type (CIEDE 2000)

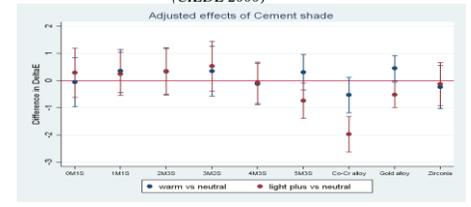


Figure 7: Cement shade effect compared to the reference neutral shade

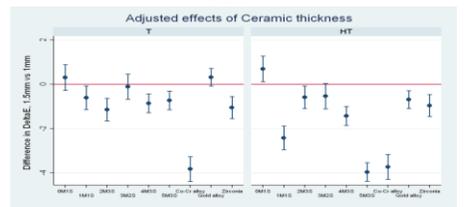


Figure 8: Comparison of 1.0 and 1.5 mm ceramic thicknesses.

Conclusion

Within the limitations of this study, the color of the monolithic CAD/CAM zirconia reinforced lithium-silicate monolithic crowns was affected by all the examined parameters; substrate color, cement color, ceramic thickness and translucency. In case of T crowns, the crown wall thickness has limited influence compared to the HT crowns. Data shows that the optical properties of these ceramic materials are highly complex, therefore before choosing the ceramic block translucency and restoration wall thickness we should consider the underlying abutment color. The final color was just barely affected by luting cement shade in case of 1.0 and 1.5 mm thick ceramic crowns, however in some cases opaque cement shades can help to mask the underlying darker (e.g:CoCr)substrate colors.

References

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