507

Resin light curing through three zirconia ceramics with different pigmentation

Gomes I[1], Portugal J[1], Fonseca M[2], Pires Lopes L[1]

[1]Faculty of Dental Medicine, University of Lisbon
[2]Center for Mathematics and Applications, Faculty of Technology and Sciences, University Nova of Lisbon

Introduction

Zirconia for biomedical applications is commonly 3Y-TZP, with grains size in the range of 0.2 to 0.5 μm[1]. Varying sintering conditions could modify grain size, which depends of the brand and may affect the translucency of zirconia[2,3].
The basic color of 3Y-TZP is white to ivory opaque. However, using a shaded zirconia core leads to better esthetic results. Most zirconia can be colored in the pre-sintered state by immersing copings in a dyeing liquid. This procedure influences the microstructure of the zirconia[4] and may affect the transmission of light through it.
The success of a ceramic restoration depends primarily on the durability of the bond between ceramic/luting agent and luting agent/enamel and dentin. When using composite resin as a luting material, the bond strength will be determined by achieving adequate resin polymerization, which depends on the transmission of light through the ceramic[5].

Objectives

To evaluate the effect of zirconia pigmentation and exposure time on the ability to light cure resin cement through three zirconia ceramic systems, according to the following null hypothesis:

H0: zirconia systems does not influence the microhardness
H0: zirconia pigmentation does not influence the microhardness
H0: exposure time does not influence the microhardness

Materials and Methods

Ceramic blades were made from each zirconia system in study **(Figure 1:A,B,C)**. Pre sintered blocks were sectioned (ISOMET, BUEHLER, Illiniois, USA) **(D)** and machine-polished on both sides with 200, 400 and 600 wet silicon carbide papers **(E)** until the thicknesses were reduced to 0.75 mm. Specimens pigmented in A1 and A4 were immersed in the respective solution **(F)**, and all specimens were then sintered, according to the manufacturer's instructions **(G)**. Full sintering process resulted, in all systems, approximately in 20% shrinkage with the final thickness being 0.6 mm ± 0.03mm **(H,I)**.
Resin cement (Variolink II Base, Ivoclar Vivadent) **(J)** disc shaped specimens (5mm x 0.5mm) were prepared. The resin was light cured (1420 mW/cm² - Bluephase 20i Ivoclar Vivadent) **(K)** through the ceramic blades **(L)**. Forty-five experimental groups were set according to the several possible combinations between 3 ceramic systems (LAVA, ICE Zirkon Translucent and Prettau Zirkon), 3 ceramic pigmentations (no pigmentation, A1, A4), and 5 exposure times (10, 20, 30, 40 and 50 seconds) (n=5). Additionally, samples were light cured without the interposition of ceramic (control group) with 60 seconds of light exposure. The ability to light cure was determined by Knoop microhardness evaluation of the resin cement **(M,N)**. Data were statistically analyzed with 3-way ANOVA followed by Tukey post hoc tests (Alfa=0.05).

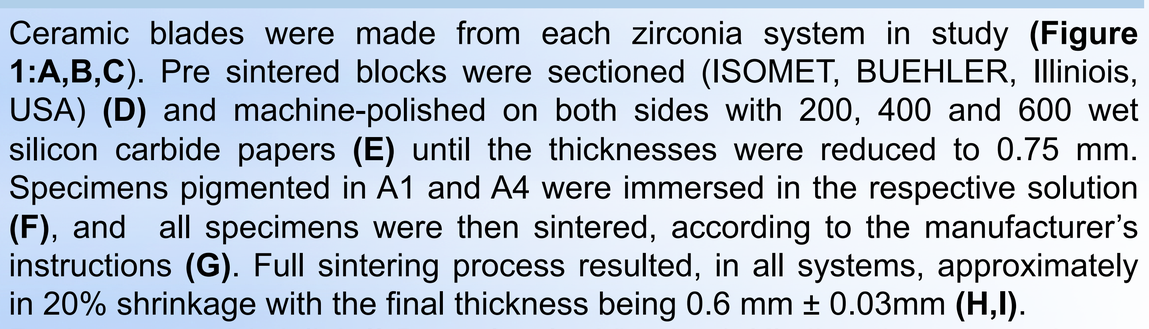

Figure 1 - Ceramic blades

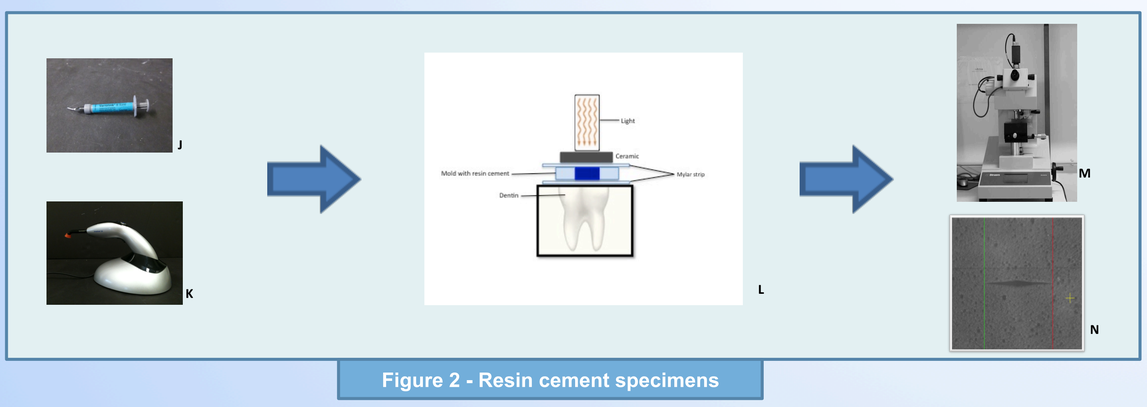

Figure 2 - Resin cement specimens

Results

The mean and the standard derivation Knoop hardness of studied ceramics, with different pigmentation at different exposure times, are shown in Figure 3.
The mean microhardness for ICE Zirkon Translucent A4, 40 seconds exposure group, obtained the higher mean with 81,6% of the mean microhardness found for the control group.
Zirconia systems ($p<0.05$), zirconia pigmentation ($p<0.05$) and exposure time ($p<0.05$) had a statistically significant effect on microhardness. It was also observed a statistically significant interaction between exposure time/ pigmentation ($p<0.05$), zirconia system/pigmentation ($p<0.05$) and exposure time/zirconia system/pigmentation ($p<0.05$). (Table 1).

Source of variation	Sum of squares	df	Mean square	F ratio	p value
Exposure time	21,622	4	5,405	114,394	<0,001*
Ceramic	0,780	2	0.390	8,252	<0,001*
Pigmentation	10,304	2	5,152	109,025	<0,001*
Exposure time/ceramic	0,189	8	0,024	0,500	0,855
Exposure time/pigmentation	1,523	8	0,190	4,028	<0,001*
Ceramic/pigmentation	0,813	4	0,203	4,301	0,002*
Exposure time/Ceramic/pigmentation	1,318	16	0,082	1,743	0,042*
Error	8,506	180	0,047		

Table 1 – Three-way analysis of variance (ANOVA).

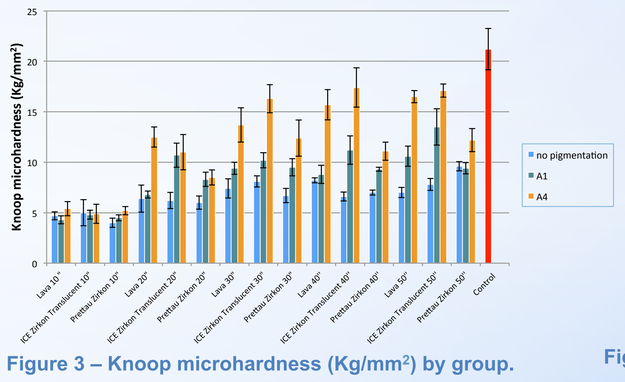

Figure 3 – Knoop microhardness (Kg/mm²) by group.

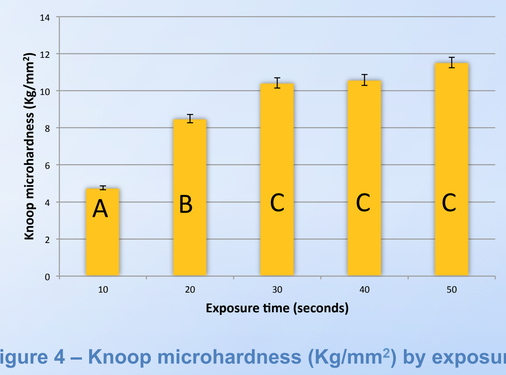

Figure 4 – Knoop microhardness (Kg/mm²) by exposure time.

[Means with same letter are statistically similar ($p \geq 0.05$)]

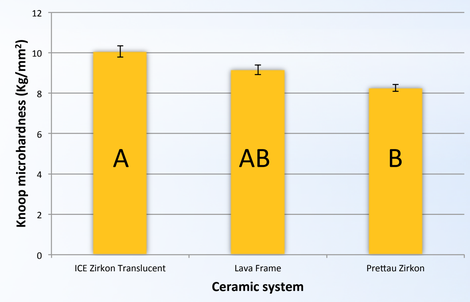

Figure 5 – Knoop microhardness (Kg/mm²) by ceramic system.

[Means with same letter are statistically similar ($p \geq 0.05$)]

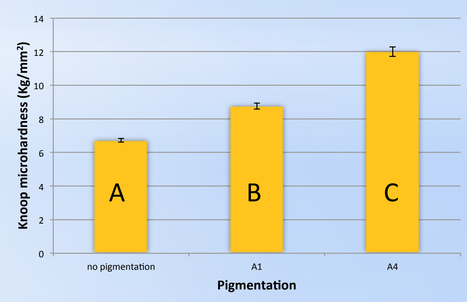

Figure 6 – Knoop microhardness (Kg/mm²) by pigmentation.

[Means with same letter are statistically similar ($p \geq 0.05$)]

Photopolymerization for 50 seconds resulted the in higher microhardness values, however they were not statistically significantly different from those obtained with 30 and 40 seconds.
Between the different zirconia systems studied the ICE Zirkon Translucent showed the higher microhardness values.
The results of microhardness obtained with the three pigmentations were all different being significantly higher with pigmentation A4. No pigmentation decreased mean microhardness.

Conclusion

The microhardness of the luting resin cement studied increased with the photopolimerization exposure time, with the pigmentation of the zirconia and was influenced by the zirconia system.

Bibliography

1. Denry I, Kelly JR (2008). State of the art of zirconia for dental applications. Dent Mater 24(3):299-307.
2. Stawarczyk B, Özcan M, Hallmann L, Ender A, Mehl A, Hämmerlet C (2013). The effect of zirconia sintering temperature on flexuralstrength, grain size, and contrast ratio. Clin Oral Invest 17(1):269–274.
3. Clarke FJ (1983). Measurement of color of human teeth. In: McLean JW, editor. Proceedings of the First International Symposium on Ceramics. Chicago: Quintessence. p. 441-90
4. Shah K, Holloway JA, Denry IL (2008). Effect of coloring with various metal oxides on the microstructure, color, and flexural strength of 3Y-TZP. J Biomed Mater Res B Appl Biomater 87(2):329-37.
5. Ilie, Hickel (2008). Correlation between ceramics translucency and polymerization efficiency through ceramics. Dental Mater 24(7): 908-914.

Thanks
To manufacturers who kindly gave all the material: 3M and Zirkonzahn.

The authors report no conflicts of interest.