Thermal Properties of Cements for Pre-fabricated Pediatric Zirconia Crowns

A. Brianne Kerns, Brian Morrow, Audrey Selecman, Martha Wells, Franklin Garcia-Godoy
University of Tennessee, Memphis, TN, USA

INTRODUCTION

Zirconia crowns are an increasingly popular choice for pediatric dental restorations. Approximately twice as much tooth structure is removed for preparation of zirconia crowns as compared to stainless steel. Prior studies have compared the retention and clinical success of common types of cement used for prefabricated zirconia crowns, but no study has been completed comparing temperature change during curing.

PURPOSE

This study aimed to evaluate if heat is produced during curing of cements commonly used for primary prefabricated zirconia crowns and whether those temperature changes are clinically significant.

MATERIALS & METHODS

Five cements - BioCem Universal (NuSmile®; Houston, Texas, USA), Ceramir Crown & Bridge (Doxa Dental AB; Uppsala, Sweden), FujiCem 2 (GC Corporation; Tokyo, Japan), Ketac Cem (3M ESPE; St. Paul, Minnesota, USA), and RelyX Luting Plus (3M ESPE) - were placed in wells and measured with FLIR E75 thermal camera for temperature change during cure. Two cements - BioCem and RelyX - were light-cured according to the manufacturer's instructions.

Three additional temperature measurements were completed for RelyX and BioCem:

1) Anterior EZCrown size E6 (Sprig, Loomis, CA, USA) was sectioned in half along the incisal edge. Facial half was placed over empty wells during light-cures, then removed to allow for temperature measurement of well underneath.
2) BioCem and RelyX placed in wells and allowed to self-cure without light.
3) Empty wells were exposed with the same light for the same time periods.

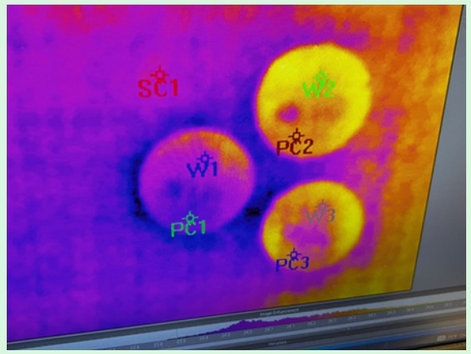

Image 1. Thermal image of wells in ResearchIR - each measurement included a 3x3 pixel area

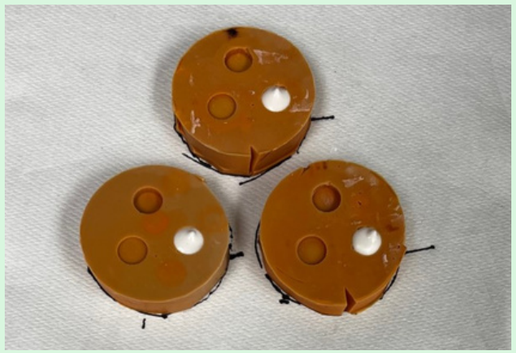

Image 2. Cement placement in 2mm x 10mm VPS wells

RESULTS

Table 1. Temperature for all experimental groups

Temp. Change in Celsius	FUJICEM	CERAMIR	KETAC	BIOCEM (standard)	BIOCEM LIGHT + ZIRC	BIOCEM NO LIGHT	BIOCEM LIGHT ONLY	RELYX (standard)	RELYX LIGHT + ZIRC	RELYX NO LIGHT	RELYX LIGHT ONLY
RUN 1-1	7.63	3.09	4.06	55.45	17.38	0.85	42.17	5.96	3.65	1.10	17.23
RUN 1-2	7.33	2.19	3.96	57.14	20.90	1.33		6.93	5.94	2.60	19.59
RUN 1-3	7.55	2.30	2.96	54.84	29.02	0.70		5.31	3.79	0.81	21.86
RUN 2-1	7.60	2.71	4.69	57.79	20.63	0.66		4.45	5.40	0.41	
RUN 2-2	8.74	1.92	4.65	55.20	27.81	1.28		6.75	10.50	6.32	
RUN 2-3	6.68	1.97	3.52	56.82	20.00	0.60		5.71	4.05	5.30	
RUN 3-1	6.98	1.92	3.68	57.43		0.49		4.04		6.90	
RUN 3-2	9.42	3.11	4.30	59.37		0.64		5.92		1.09	
RUN 3-3	8.84	2.68	3.77	54.93		1.85		5.13		1.64	
Average	7.9	2.4	4.0	56.6	22.6	0.9	42.2	5.6	5.6	2.9	19.6
Std. Dev.	0.9	0.5	0.6	1.5	4.7	0.5	-	1.0	2.6	2.6	2.3

Table 1 shows the average temperatures with standard deviation that were recorded during cure for the five cements we tested.

Data are statistically analyzed using Kruskal-Wallis One-Way ANOVA on Ranks with Tukey post hoc test for multiple comparison ($p<0.05$) (Figure 1). Statistical differences ($p<0.05$) existed between RelyX, Ketac Cem, and Ceramir when compared to BioCem. Statistical differences also existed between FujiCem and both Ketac Cem and Ceramir. No statistical difference was found in exotherm for RelyX and Ketac or Ketac and Ceramir, but statistical difference found between RelyX and Ceramir.

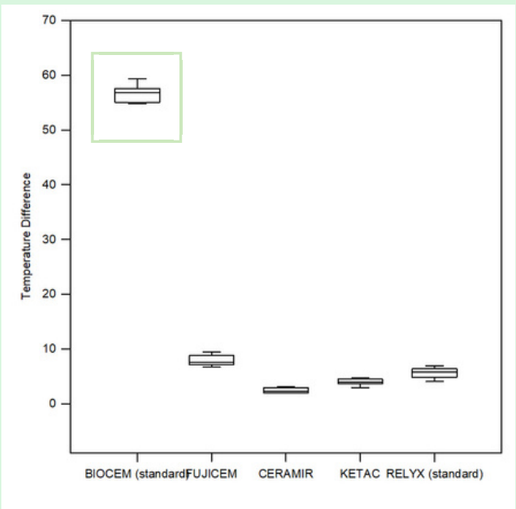

Figure 1. Temperature difference during cement cure

DISCUSSION

In a classic study with Rhesus monkeys, a pulpal temperature rise of 5.5 degrees caused degenerative histologic changes in 15% of population (Zach L, Cohen G, 1965). Based on this, clinically-significant temperature rise was found for BioCem when cured according to manufacturer's instructions, even when crown placed between the light and the well. Heat generated from light curing cement amidst significant tooth reduction poses a significant risk for pulpal damage, especially for primary 1st molars prepared for pre-fabricated zirconia crowns.

CONCLUSIONS

Clinically significant temperature rise is noted during cure for BioCem. Additional studies are warranted for these cements to investigate intra-pulpal temperature rise and possible damage to pulpal tissue.