Effects of Initiator/Co-initiator Levels on Dental Resin

Nykesha Karmaker
SFC LLC, Wallingford, CT, USA

ID #: 1619

OBJECTIVE:

The objective of this study was to investigate the effect of type I and type II photo-initiators containing varying levels of co-initiator (DMAEMA) on mechanical properties in dental resin. The effects were assessed by conducting flexural strength tests. ANOVA single factor test was applied to determine statistical differences between each type.

INTRODUCTION:

The type of photo-initiator, co-initiator and their levels effect the quality of photo-polymerization, degree of conversion, and the mechanical properties of dental resin. The mechanical property discussed in this study is 3-point flexural strength. This study evaluates the effects of initiator/co-initiator levels in Bis-GMA/TEGDMA resin matrix. Two types of photo-initiators were used: type 1 Diphenyl (2,3,6 Trimethylbenzoyl) Phosphine Oxide (TPO) and type 2 Camphorquinone (CQ). Typically, a co-initiator is not added to type 1 but in this study co-initiator Dimethyl Amino Ethyl Methacrylate (DMAEMA) was added to both type 1 and type 2 for better comparison between initiators. The ratios of TPO/DMAEMA levels and CQ/DMAEMA levels varied to determine their effect on mechanical properties.

MATERIALS & METHOD:

Two groups of test samples were prepared with either group 1 (TPO) or group II (CQ) photo-initiator. Resin consisted of 50% Bis-GMA and 50% TEGDMA, and .02g of BHT inhibitor, by weight. Flexural strength specimens were prepared by using a Teflon mold with a 2 mm x 2 mm x 25 mm cavity. Resin was light cured for 40 seconds each side using a handheld light cure unit (Avante, Pentron), followed by additional 2-minute cure in light box (Cure-Lite Plus, Pentron). They were submerged in water and stored for 24 hours, at room temperature, in a cylindrical plastic jar. After 24 hours, samples were taken out and polished with sandpaper (P400, 3M) to remove rough edges. The width and height of specimens were measured using a digital caliper (UltraTech, from General Tools). A custom-made mechanical device with a digital force gauge (Chatillon, DFX from Ametek) was used to perform flexural tests. Specimens were placed on two points with a support distance of 20 mm and force was slowly and consistently applied with an indenter (2mm diameter) at the center until they broke. Peak force was registered, and flexural strength was calculated using the equation given in ISO 10477. To calculate the statistical results, Microsoft Excel was used.

EQUATIONS USED:

1. $\text{Flexural Strength (MPa)} = \frac{1.5*F*L}{W*H^2}$

2. $\text{COV. (\%)} = \frac{\text{St.Deviation}}{\text{Ave.Strength}} * (100)$

3. $\text{Null Hyp. } (H_0): \bar{x}_{i_1} = \bar{x}_{i_2}$ & $\text{Alt. Hyp. } (H_A): \bar{x}_{i_1} \neq \bar{x}_{i_2}$

4. $df = n_{i_1} + n_{i_2} - 2$

5. $SE_{\bar{x}_i} = \frac{\sigma}{\sqrt{n}} = \frac{s_i}{\sqrt{n}}$

6. $S_p = \sqrt{\frac{(n_1-1)*{s_{i_1}}^2 + (n_2-1)*{s_{i_2}}^2}{n_1+n_2-2}}$

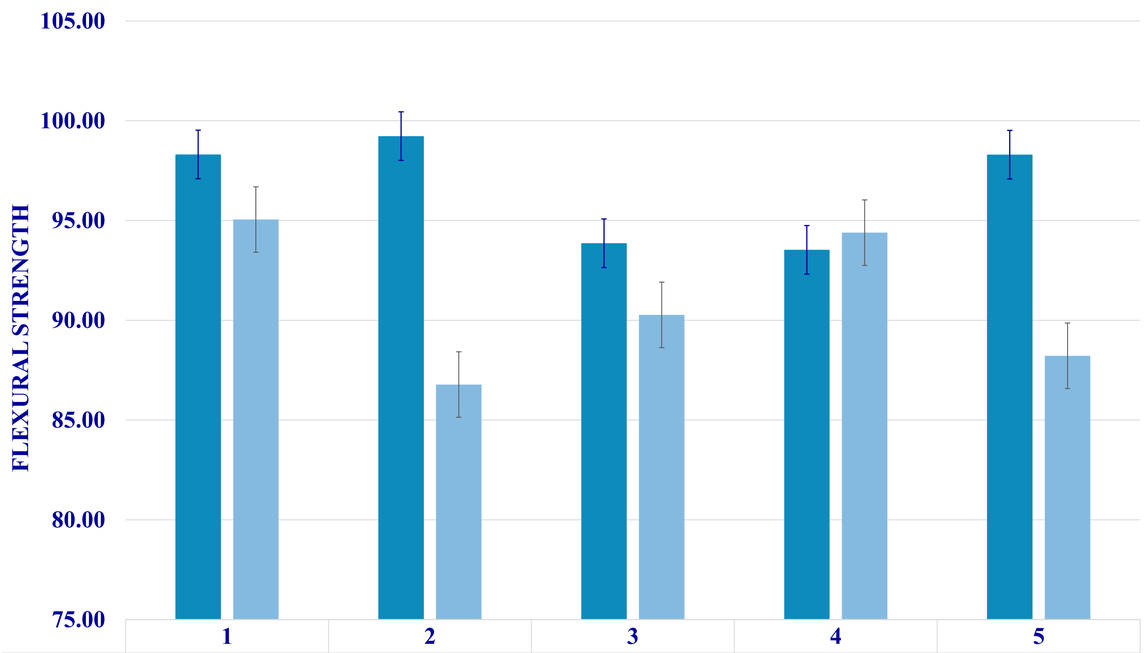
7. $SE_{(\bar{x}_{i_1}-\bar{x}_{i_2})} = Sp\sqrt{\frac{1}{n_{i_1}} + \frac{1}{n_{i_2}}}$

8. $t = \frac{(\bar{x}_{i_1}-\bar{x}_{i_2})}{SE_{(\bar{x}_{i_1}-\bar{x}_{i_2})}}$

RESULTS:

The results for flexural strength and statistical analysis are shown in the tables and graph below. The highest average flexural strength of type 1 is 99.23 MPa, so it was used as a reference when finding t and p values for each group comparison. According to ANOVA single factor test for type 1, the p-value is 0.56 so there is no statistical difference. The highest average flexural strength of type 2 is 95.05 MPa, so it was used as a reference when finding t and p values for each group comparison. According to ANOVA single factor test for type 2, the p-value is 0.33 so there is no statistical difference. For type 1 vs. type 2, the p-value is 0.10 so there is no statistical difference between the two types of initiators.

TPO VS. CQ AVERAGE FLEXURAL STRENGTH:



	1	2	3	4	5
TPO	98.31	99.23	93.86	93.53	98.30
CAMPH.	95.05	86.78	90.27	94.39	88.22

TPO VS. CQ.

Sub-group	Flexural Strength (MPa)	
	Group I Averages-TPO	Group II Averages-CQ
1	98.31±5.08	95.05±8.42
2	99.23±5.08	86.78±10.62
3	93.86±8.48	90.27±4.57
4	93.53±10.18	94.39 ±4.51
5	98.30±3.63	88.22±6.87

Anova: Single Factor: TPO vs. CQ Flexural Strength

SUMMARY						
Groups	Count	Sum	Average	Variance		
TPO Group 1	5	491.54	98.31	25.77		
TPO Group 2	5	496.16	99.23	25.83		
TPO Group 3	5	469.29	93.86	71.91		
TPO Group 4	5	467.67	93.53	103.59		
TPO Group 5	5	491.49	98.30	13.20		
CQ Group 1	5	475.27	95.05	70.82		
CQ Group 2	5	433.89	86.78	112.69		
CQ Group 3	5	451.34	90.27	20.85		
CQ Group 4	5	471.95	94.39	20.30		
CQ Group 5	5	441.09	88.22	47.14		
ANOVA						
Source of Variation	SS	df	MS	F-val.	P-val.	F-crit
Between Groups	825.01	9	91.67	1.79	0.10	2.12
Within Groups	2048.38	40	51.21			
Total	2873.39	49				

CONCLUSION:

According to ANOVA Single Factor test for group 1 vs. group 2, the f-value is 1.79, the p-value is 0.10, and the f-critical is 2.12. The p-value is greater than the level of significance α=0.05, so there are no significant differences between the groups nor their sub-groups and the null hypothesis $\mu^1=\mu^2$ must be accepted.