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Comparison of Shrinkage Stress of 3 Posterior Composites with a Universal Posterior Composite

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ABSTRACT

The purpose of this study was to compare the polymerization shrinkage stress of three posterior composites with a universal composite (Z-250, P-60, Tetric-N-ceram and Photocore) by Bioman method. A Bioman instrument was employed to determine the shrinkage stress kinetics following 40s irradiation (400 mW/cm²) at 25°C. All data were captured for 5 minutes and the final shrinkage stress calculated. There were no significant difference between Z-250, P-60 and Tetric-N-ceram while the shrinkage stress among Photocore and Tetric-N-ceram was significant at 40s. We haven't observed significant difference between all composites at 5 minutes.

Key words: Shrinkage stress, Posterior composites, Universal composite

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INTRODUCTION

In the last two decades, the large number of studies involving composites in the different countries led these materials to improved mechanical properties and esthetics. However, they still present the contraction during polymerization process as a major problem. This shrinkage can be understood as densification or loss of volume [1-4].

Polymerization shrinkage is the chemical reaction that transforms small molecules into large polymer chains or networks. Monomer molecular are at inter molecular distance of 3-4 A°, but when they polymerize, the distance between the so formed polymer units is poly 1.5 A° [5].

The magnitude of polymerization stress of composites are determined by the number of covalent bonds formed, that is by the degree of conversation of the double carbon bonds of the monomers, as well as by the size of these molecules [6]. Some Factors like light curing modulation, increment size, C-Factor, base material, type and percentage of monomer and filler may determine the degree of shrinkage stress of composites [7,8].

Bioman's invented by Mr. Watts to evaluated the shrinkage stress of composites. This instrument can evaluated these force by movement of rod thickness and cross section of composites [9].

This study evaluated the shrinkage stress of 3 type of posterior and one type universal composites by Bioman instrument and compared them.

MATERIALS AND METHODS

In this study three types of posterior composites (n=5) were compared to a universal composite (n=5), and we used to measure the stress as Bioman stress measurement device. The Bioman instrument is made of a steel rod (10 mm in diameter) connected to a load cell on one side, and a glass slab on the other side. The composite samples used in this study which were placed between the glass slab and the steel rod had a c-factor equal to 2.5 (Equation 1).

$$C_f = \frac{bonded\ surfaces}{unbonded\ surfaces} = \frac{2\pi r^2}{2\pi rh} = \frac{r}{h} \qquad (1)$$

For each material, five specimens were tasted at room temperature (25°C). All composite samples were weighed to be 0.3 grams before being placed in the Bioman instrument. The weighed sample composites had a thickness of 1 mm, and a diameter of 10 mm, and they were placed between the glass slab and the steel probe (sandwich-shaped). To avoid a destructive force and maintaining relaxation, samples were left for one minute in the place. Composite samples were cured by a tungsten halogen light cure (Optilux 500, Kerr, Orange, CA, USA) for 40s at an intensity of 400 mW/cm^2 without distance. The stress produced within the material during polymerization, and thus between the glass slab and the rod, caused a displacement of the free end of the load cell. The amount of shrinkage stress in the composites was measured by the load cell connected to a computer, and the data was recorded on the computer. Because the composites have post-curing shrinkage stress, the measuring was implemented for 5 minutes. For each composite to be tasted the final shrinkage-stress of each of the five runs was recorded and the mean and standard deviation calculated (Table 1). These values were entered into a statistical package.

RESULT

The final shrinkage stress of all composite is presented in Figure 1. The lowest shrinkage stress at 40s was seen in Tetric-N-ceram and maximum shrinkage stress at 40s was seen in Photocore. The result of Figure 1 showed that there is no significant difference between Tetric-N-ceram, Z-250 and P-60 at 40s while difference between Tetric-N-ceram and Photocore were significant. Z-250 didn't have significant difference with all composites.

Also results of all groups were compared at 5 min in Figure 1 and it showed that none of them have significant difference.

DISCUSSION

The Bioman instrument used for shrinkage stress measurement proved to be convenient, economical of space and resource, and gave reproducible results. This instrument uses a beam of fixed compliance, although this method is not universally employed for stress measurements. Configurations with minimal compliance are often employed where the major sources of compliance (the load cell and specimen holders) are compensated for using a computer controlled testing machine with a feed-back system [10,11]. These techniques aim to maintain a constant strain, with no deformation of the sample; in fact, the instrument feed-back settings may lead to pseudo-cycling of the material with the sample being contracted by the polymerization shrinkage then stretched by the corresponding feed-back force [12], and it is not possible to compensate fully for the system compliance [11-13]. Testing of samples in systems that allow for deformation yields lower results than the majority of studies [11]. Given that teeth are not fully rigid and although not easily deformable, will deform under applied stress [14-16], a system with a fixed compliance seems appropriate: the Bioman apparatus has a fixed beam length and therefore fixed compliance, detects the deflection of a cantilever beam due to shrinkage stress and is such a system.

Table 1: The final shrinkage-stress of each of the runs

Group	Brand Name	Number	Application	Manufacturer	Monomers	Volume (%)	Flexural Modulus
1	Tetric-N-ceram bulk fill	5	posterior	Ivocolar, vivadent, schoan, Lichetoustain	Dimethacrylate camonomers	60% Vol	8.5 Gpa
2	Photocore	5	posterior	Kurary, Okayama	TEG DMA, Bis-GMA	68% Vol	12.4 Gpa
3	Filtek Z-250	5	universal	3M, ESOE, St paul, MN	Bis-GMA, Bis-EMA, UDMA, TEGDMA	60% Vol	10.5 Gpa
4	Filtek P-60	5	posterior	3M, ESOE, St paul, MN	Bis-GMA, Bis-EMA, UDMA, TEGDMA	61% Vol	11.2 Gpa

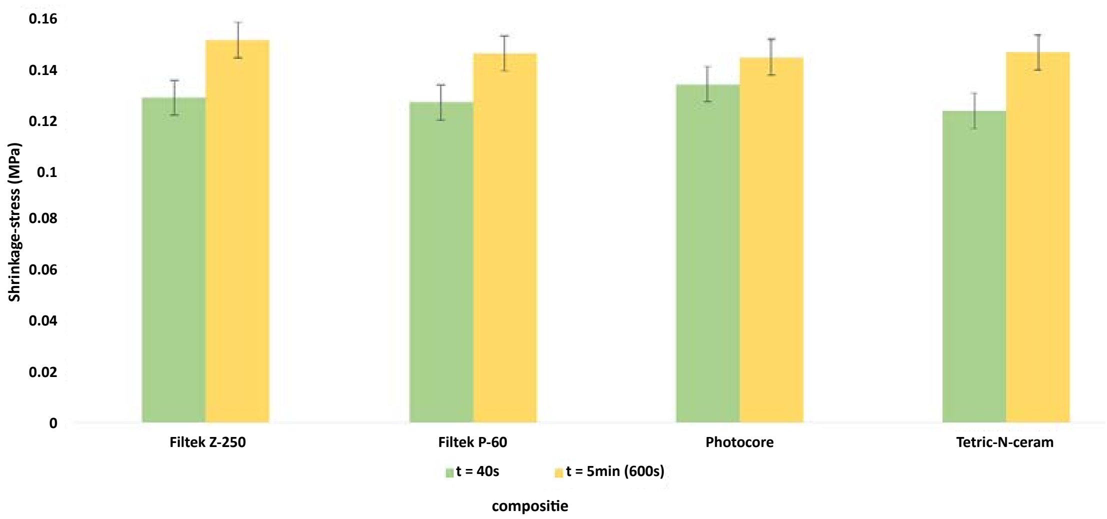

Figure 1: The final shrinkage stress of all composite; 40s: The minimum shrinkage stress at 40s was seen in Tetric-N-Ceram and maximum shrinkage stress was seen photocore; 5 min: It was observed that none of them have significant difference.

Some of manufactures are trying to change matrix resins to reduce dual bonds in composites. If double carbon bonds reduce. The polymerization shrinkage will reduce too. Away that is using in manufactures to reduce polymerization shrinkage is use of UDMA or Bis-EMA instead of TEG-DEMA in matrix resins [17].

TEG-DMA has a few molecular weights and a lot of double resin carbon bonds. Polymerization shrinkage of TEG-DMA is more than Bis-GMA, because of this characterize of TEG-DMA, Bis-EMA is replacing in Z-250 and P-60 composites to reduce shrinkage stress [14]. Another factor that has effect on magnitude of shrinkage stress is filler particle volume. If amount of filler volume increase, composites becomes stiffer and its shrinkage stress increase too. This study, all of composites have different formulation in matrix resins and volume of the filler particle. In Table 1, 68% volume of photocore is filler particle and flexural modulus of it is more than other composites. In following of the studies by Chen et al. and Calheiros et al., that explain amount of filler particle and flexural modulus have effect on shrinkage stress [10,18,19], we related shrinkage stress of composites to volume of fillers particle and their flexural modulus, although a lot of factor can change it. The final shrinkage stress for each posterior composite is presented in Figure 1. The lowest shrinkage stress at 40s was seen in Tetric-N-ceram and highest shrinkage stress at 40s was seen in photocore. We have compared the results of all the groups in 40s. It showed that we haven't observed significant difference between Tetric-N-ceram, Z-250 and P-60 at 40s, while Tetric-N-ceram and photocore had significant difference. None of the composites have significant difference after 5 minutes.

CONCLUSION

Based on the results of this study, minimum shrinkage stress was observed in the Tetric-N-ceram bulk fill composite, while the Filtek Z-250 composite didn't have any significant difference with this composite and its shrinkage stress was in the middle of the photocore and Filtek P-60 posterior composites. However, by adjusting light sources and the intensity of them or changing the C-Factor of composites samples, these results may change.

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