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Evaluation of Polymerization Shrinkage of Light Cured Composite Resins

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ABSTRACT

Aim: The purpose of this study was to evaluate the polymerization shrinkage of four different light cured composite resins used for restorative purposes by measuring shrinkage strain.

Materials and Method: Thirty composite samples were divided into three groups of ten each. An experimental design was made to record the shrinkage strain while curing the composite sample. The readings were recorded and statistical analysis was done.

Results: Results showed samples in group II (fiber reinforced composite) had least polymerization shrinkage whereas group III (Nano filled composite) had the highest shrinkage.

Conclusion: Resin matrix composition, filler volume, type of filler and lot of other factors has to be considered before selecting a composite resin for a successful restoration.

Keywords: Composite resins, Light cured, Polymerization.

INTRODUCTION

Caries continues as the most prevalent malady in dentistry despite remarkable advances in prevention over the past few decades. Currently, the only treatment for carious lesions is tooth restoration by placement of an inert material that acts as a block to further decay. Modern composite restorations are composed of silane-coated inorganic filler particles and adhesive resins (reactive monomers and cross-linking agents). Composites are more aesthetic and lack undesirable metals, but may have shorter lifetime than amalgam especially in molar teeth. Much of this decreased performance is due to the physical realities of the polymerization process as the composite material sets into the prepared site in the tooth. For example, marginal leakage due to polymerization shrinkage has been cited as a major problem of resin composites. Thus, while progress has been made on understanding the mechanisms that led to composite restoration failure, there has been little progress in solving the underlying problem(s). Therefore, there is a need for research to develop the next generation of dental restorative materials that possess the combination of the mechanical properties of amalgam and the tooth-like esthetics.

Composites contract about 1 to 5 volume % during the polymerization process[1]. Studies have shown that more bond failures have occurred in the tooth structure and composites during the post-gel polymerization stage[2]. Over the past few decades, lot of efforts have been centered on understanding

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the chemistries within the composite, such as driving the polymerization reaction to completion, excluding water from the binding surface of the dentin and layering large restorations to dissipate heat and shrinkage stresses gradually[3,4,5].

The aim of the study is to evaluate the polymerization shrinkage of three different light curing composite resins.

MATERIALS AND METHODS

Thirty samples were divided into three groups each consisting of ten samples. The strain-gauge method was used to measure the development of post-gel shrinkage of the light activated restorative composites.

Group I – 3M Z 250 (Micro hybrid composite)

Group II – Nulite F high strength (Fiber reinforced composite)

Group III – 3M Z 350 (Nano filled Composite)

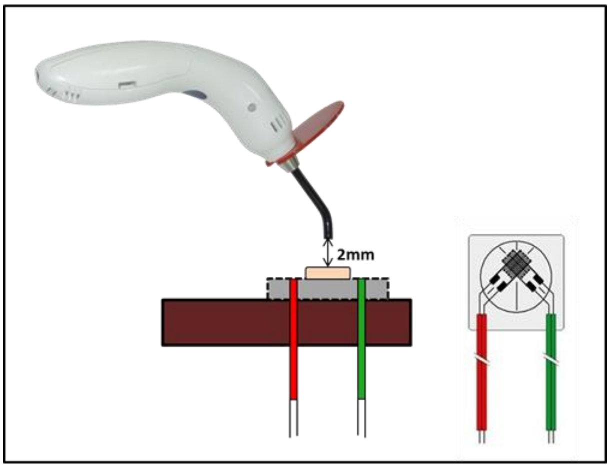
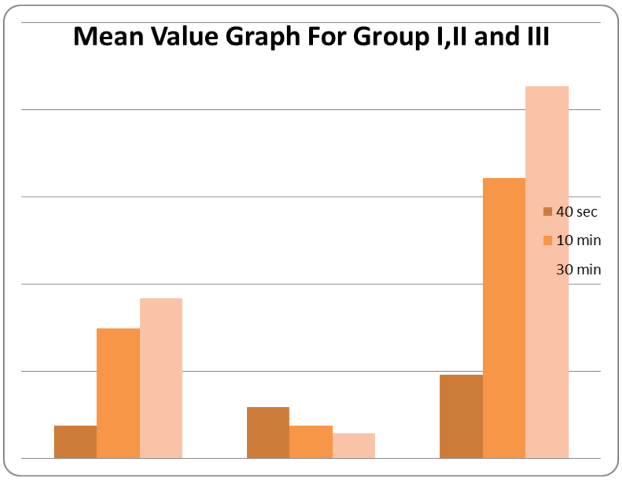


Fig 1: Showing experimental design made for measuring the postgel shrinkage.

An experimental design was made for measuring the post gel shrinkage (Figure 1). Shrinkage strains at the bottom of the composite samples were measured in two perpendicular directions using a biaxial stacked strain gauge (CEA-06-032WT-120, Measurements Group). Uncured composite of 1mm thickness was placed on the strain gauge. The sample area attached to the strain-gauge backing was approximately 9 mm^2, while the actual gauge area was 0.656 mm^2. This ensured that the sample boundary artifacts would not affect the measurement area. The light intensity that reaches the composite from a light source diminishes with increasing distance from the light curing tip. In this shrinkage experiment, the distance of the curing light guide was standardized at 2mm above the sample. Samples were light cured for 40 seconds. The output of the photocell was placed next to the composite sample and was recorded with the strain outputs to register the exact beginning and duration of the light cure. The shrinkage strain was recorded for 10 minutes after initial light activation. The relationship between shrinkage strain and time was obtained by averaging the two perpendicular strain components. Postgel shrinkage values at 40 seconds, 10 minutes and 30 minutes were used for statistical analysis.

Table 1: mean and the standard deviation values were compared by students paired t-test.

Time	Group I	Group II	Group III
40 sec	18.7 ± 10.2	29.2 ± 7.2	48.2 ± 10.6
10 min	74.4 ± 21.78	18.6 ± 4.3	161.1± 30.43
30 min	91.7± 20.2	14.21 ± 3.5	213.8 ± 52.4



Graph 1: Mean Value of Micro strain Value for Groups I, II and III at 40 sec, 10 min and 30 min.

RESULTS

The mean and the standard deviation values were compared by students paired t-test. Multiple range tests by Tukey – HSD procedure was used to identify the significant group if p value was significant. Group I showed less polymerization shrinkage at 40 secs compared to group II and group III. Group II showed least polymerization shrinkage compared to group I and Group III at 10 and 30 minutes. Among all the groups Group III showed high polymerization shrinkage at all the time intervals (Table 1 and Graph 1).

DISCUSSION

Inspite of various advantages of composites, in order to overcome the main drawback that is, the polymerization shrinkage, lots of efforts are made by improving the formulation of these materials[1,6,7]. The setting reaction is accomplished by volumetric shrinkage of varying magnitude, depending on the resin formulation[8,9]. The debonding stresses resulting from the shrinkage can cause post-operative sensitivity[10,11], opening of the restoration margins leading to microleakage and secondary caries[3,12,13,14]. Many methods and techniques have been employed to minimize polymerization shrinkage with varying degree of success. Use of sandwich technique[5], low viscosity composites as first increment[8], incremental insertion of composites[3] light transmitting wedges[9], soft-start polymerization[10,11] have been used to minimize the shrinkage. But by varying the resin matrix composition, type of filler, filler particle size and the filler volume[15,16], new composites have been developed such as the fiber reinforced composite and nano composite. The dimensional change due to polymerization starts from the beginning of polymerization and continues over a period of time and hence the shrinkage was studied at 40 secs, 10 min and 30 min intervals.

In this study, the resin matrix of group I and Group III are similar except that group III consists TEGDMA apart from Bis-GMA, UDMA and Bis-EMA. UDMA and Bis-EMA have high molecular weight than TEGDMA which is known to reduce polymerization shrinkage[17]. The resin matrix of group II has only Bis-GMA. All Bis-GMA resins shrink to some extent, but the contraction can be reduced by adding monomers of low molecular weight where as high percentage of low molecular weight monomers such as TEGDMA exhibit high volumetric shrinkage and hence high contraction stress[18, 19, 20].

Apart from the resin matrix, stiffness and flow ability of the composites are also important factors affecting the development of stresses which are related to the filler content[21]. Among all the groups, Group II had the highest filler content (71%) which showed least polymerization shrinkage. Group I (60%) and group III (59.5%) had same filler volume content but yet shrinkage was more in group III which can be attributed to the filler particle size which may also play a role in the polymerization shrinkage[17]. Even though the size of filler particles was least in group III with a mean particle size of 5 to 20 nm, it showed high polymerization shrinkage which may be due to the presence of nano particles as well as clusters with a mean size of 0.6 to 1.4 microns along with resin matrix composition. On the contrary group II had a filler size of 0.04 to 16 microns but showed least polymerization shrinkage.

From the above discussion, it can be concluded that shrinkage stress does not depend on one single factor. According to the manufacturer, fiber reinforced composites (Group II) are incorporated with polyethylene fibers, Bis-GMA resin matrix and the mean filler size range of 0.04 to 16 microns with a filler volume percentage of 71% which could have been the reason behind the low polymerization shrinkage when compared to group I and Group III. But any how the exact mechanism is still elusive and further in vivo studies are required to study the same.

CONCLUSION

When placing a white composite filling into a decayed tooth, the devil is always in the polymerization process. That's when dentists shine a high-energy light onto the dough-like filling packed into the cavity, prompting small unbound molecules or monomers within the material to link into polymer chains. But as the chains assemble and produce the cross-linked matrix of what will be in a matter of seconds a hard white filling, dentists also confront a basic law of chemistry. The chemical reaction that enjoins the monomers also causes them to shrink slightly. If too much shrinkage occurs during the polymerization process, the chances increase that the composite will fail prematurely.

Therefore within the limitations of this study it revealed that all composite resins do shrink but the filler volume, filler size, resin matrix play a vital role in the polymerization shrinkage apart from the clinical technique of insertion and curing of the composite resin. Since addition of micro rod fillers in the resin matrix showed least polymerization shrinkage, this study supports the use of fiber reinforced composites. Clinical significance of these findings must be verified with parallel clinical studies.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Davidson CL, Feilzer AJ. Polymerization shrinkage and polymerization shrinkage stress in polymer based restoration. J Dent. 1997;25(6):435-40.

2. Feilzer, A.J.; de Gee, A.J.; Davidson, C.L. Setting stress in composite resin in relation to configuration of the restoration. J. Dent. Res. 1987;66(11):1636-9.

3. Davidson CL . Resisting the curing contraction with adhesive composites. J Prosthet Dent. 1986;55(44):446-7.

4. Feilzer AJ, de Gee AJ & Davidson CL. Curing contraction of composite and glass ionomer cements. J Prosthet Dent. 1988;19:191-8.

5. Krejci, I, Lutz, F, and Krejci, D. The influence of different base materials on marginal adaptation and wear of conventional Class II composite resin restorations. Quintessence Int. 1988;19(3):191–8.

6. Yap AU & Wang HB. Polymerization Shrinking of visible light cured composite, Oper Dent. 2000; 25(2):98-103.

7. Sakaguchi RL, Sasik CT, Bunczak MA, Douglas WH. Stain gauge method for measuring polymerization contraction of composite restoration. J Dent 1991;19(5):312-6.

8. Bayne SC, Thompson JY, Swift EJ Jr, Stamatiades P, Wilkerson M. A characterization of first generation flowable composite. J Am Dent Assoc. 1998;129(5):567-77.

9. Aschheim KW, Dale BG. Esthetic dentistry: a clinical approach to techniques and materials. 2nd ed. St. Louis: Mosby; 2001.

10. Sakaguchi RL Berge HX. Reduced light energy density decreases postgel contration while maintaining degree of conversion in composites. J dent 1998; 26(8): 695-700.

11. Dennison JB, Yaman P, Seir R, Hamilton JC.. Effects of variable light intensity on composite shrinkage. J Prosthet Dent 2000; 84(5): 499-505.

12. Bausch JR, de Lange K, Davidson CL, Peters A, de Gee AJ. Clinical significance of polymerization shrinkage of composite resins. J Prothet Dent 1982; 48(1): 59-67.

13. Kemp Scholte CM & Davidson CL. Marginal sealing of curing contraction gaps in class V composite resin restoration. J Dent Res 1988;67(5):841-5.

14. Torstenson B & Oden A. Effects of bonding agent types and incremental techniques on minimizing contraction gaps around resin composites. Dent Mater 1989;5(4):218-23.

15. Suliman AH, Boyer DB, Lakes RS. Polymerization shrinkage of composite resine: Comparison with tooth deformation. J Prosthet Dent 1994; 71(1):7-12.

16. Labella R, Lambrechts P, Van Meerbeek B, Vanherle G. Polymerization shrinkage and elasticity of flowable composites and filled adhesives. Dent mater 1999;15(2):128-37.

17. Aw TC & Nicholls JI. Polymwrization shrinkage of densely – filled resin composites. Oper Dent 2001;28(5):498–504.

18. Feilzer AJ & Dauvillier BS. Effects of TEGDMA/Bis GMA ratio on stress development and viscoelastic properties of experimental two – paste composites. J Dent Res 2003;82(10):824-8.

19. Alvarez-Gayosso C, Barceló-Santana F, Guerrero-Ibarra J, Sáez-Espínola G, Canseco-Martínez MA. Calculation of contraction rates due to shrinkage in light–cured composites. Dent Mater 2004;20(3):228-35.

20. Braga RR, Ballester RY, Ferracane JL. Factors involved in the development of polymetization shrinkage test in resin – composites: a systematic review. Dent Mater 2005;21(10):962-70.

21. Cadenaro M, Biasotto M, Scuor N, Breshi L, Davidson CL & Lenarda RD. Assessment of polymerization contraction stress of three composite resins. Dent Mater 2008;24(5):681-5.

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