ORIGINAL ARTICLE

To Evaluate the Effect of Shef life on Depth of Cure of Polyacid-Modified composite – An In Vitro Study

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ABSTRACT

Objective: The present study aimed to compare the curing depth of chemically similar Polyacid-modified composite resins (PAM-C) having different expiry periods.

Methods: The curing depth of the PAM-C, Dyract Extra (Dentsply, U.K.) was determined for a near expiry and a long expiry material using a scraping method based on ISO 4049:2000. Samples were light-cured (800 mW/cm^2 at 40 seconds) in plastic mould. Immediately after light-curing the cylinder shaped material was removed from the mould, height of the cylinder of cured material was measured by using digital caliper and taken as the curing depth. The means of the curing depth of two materials were subjected to two sample independent t test using SPSS.

Results: The mean value of depth of cure for near expiry PAM-C (Group-A) was 6.389 mm (sd ± .202) and that of long expiry material PAM-C (Group-B) was 7.087 mm (sd ± .149). The curing depth differed significantly between the materials of the two groups (P<0.001).

Conclusion: The curing depth greatly varies between the materials. It may be inferred that the curing depth of the two assigned groups of PAM-Cs depend on the period of expiry of the material.

Key words: Shelf life, Depth of cure, Polyacid modified composite.

INTRODUCTION

Polyacid-modified composites were devised by combining the aesthetics of traditional composite resins and fluoride releasing ability of GIC cements. These materials were an amalgamation of "Compo" meaning composites and "omer" from glass-ionomer cements.[1]

Compomers like traditional composites contain resin phase containing BISGMA or UDMA diluted with TEGDMA, an inorganic non reactive filler phase of quartz, aluminosilicate glass or SrAlFSiO4 particles along with a photoinitiator system.[2] A silane coupling agent is used to create a bond between the filler and the resin phase.[3]

The differentiating factor between compomers and traditional composites is the presence of additional monomers TGB with acidic functional groups. Due to this modification compomers are also referred to as polyacid-modified composites.[4]

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They set by polymerization reaction of the acidic monomers since they contain camphorquinone as an initiator and amine as the accelerator. On exposure to radiation energy released from the lamps, the initiators form free radicals and addition polymerization reaction commences to form polymers.[5]

Historically, UV lamps were used to photo-polymerize the composites. Because of their limited ability to penetrate deep within the material, harmful effects on human eye and possible changes in oral microflora, UV lamps have been replaced by visible light lamps.[6]

Contemporary curing lamps used to cure resin based restorative materials are halogen lamps, LED lamps and plasma arc curing lamps. The amount of radiation reaching a certain depth in a material may depend on the factors such as lamp output intensity, exposure time, distance from light source to material and curing depth.[7]

LED lamps have gained popularity over low intensity halogen lamps due to their ability to cure compomers at greater depths.[8]

The contributing factors in curing depth of resin composites are chemical composition and shade of resin composite, light intensity and wavelength.[9]

Compomers like composites are hydrophobic but also imbibe water and promote secondary acid base reaction.[10]

As far as polymerization is concerned, compomers also have similar problems as those of dental composites i.e. limited depth of cure and formation of contraction stresses.[11]

These stresses can be reduced by the uptake of water, however, depth of cure of compomers vary widely depending on the brand and shade of compomers used. Koupis using scraping method and the penetrometer demonstrated that the curing depths of compomers can be smaller than the microfilled resin composite. He concluded that compomers with shade A-2 have greater values of depth of cure as compared to other shades. 2 mm incremental placement of the material to the cavity is also advised.[12]

It is a common practice but not reported in any literature that some dental professionals in local settings prefer to buy and use materials having very short expiry as these are available at cheaper prices. The present study was performed to evaluate whether this practice would make any difference in polymerization of the material when it is compared with a material having a long expiry date.

The aim of the present study was to evaluate the effect of shelf life on the depth of cure of polyacid-modified composites.

The null hypothesis for this study was that the depth of cure of PAM-C did not differ for two materials having short and long expiry times.

MATERIALS AND METHODS

The experimental study was conducted at the Operative Dentistry Department and Science of Dental Materials Lab of Dr. Ishrat ul Ebad Institute of Oral Health Sciences, Dow University of Health Sciences, Karachi, Pakistan.

The material under investigation in the present study consists of Urethane dimethacrylate (UDM), TCB resin Tri ethylene Glycidyl dimethacrylate (TEGDMA), camphorquinone UV stabilizers, Strontium-alumino-sodium-fluoro-phosphor-silicate glass, highly dispersed silicon dioxide, Strontium fluoride, Iron oxide and titanium oxide pigments.

Sample size

Sixty cylinder shaped specimens, divided into two groups i.e. Group A (n=30) comprising of specimens having near expiry date and Group B (n=30) comprising of specimens having long expiry date.

The depth of cure of the materials was determined according to ISO 4049:2009. Compomer of the each group was filled into a plastic mould (Dentsply - Caulk, UK) of dimension 4mm X 8mm. The excess material was removed by pressing a glass slide against the top of the plastic mould. The material was light cured using a LED light (Hilux) for 40 seconds and a 0.5 mm distance from the tip of the curing light to the upper surface of the filled mould was maintained. The power density of the light was checked with a radiometer before every cure and was maintained at 800 mW/cm^2. 30 samples were prepared for each testing group i.e. one group having Dyract Extra PAM-C (Dentsply – Caulk , UK) of near expiry date (One week from expiry) and another group consisting of the same material having a long expiry date (2 years from expiry).

Each cylinder shaped specimen of the cured material was removed from the mould and the soft un-polymerized material was scraped off using a plastic spatula. The length of the remaining material was measured by using a digital caliper (Nakamura Mfg. Co., Ltd, Tokyo, Japan) and recorded as the curing depth. The samples having fissures or curing defects were excluded and new specimens with perfect dimensions were prepared to be included.

Statistical Analysis

The data were entered in the spss version 16. Two samples t test with 95% confidence interval was used to determine statistical difference between the mean values of the near expiry and long expiry PAM-C.

RESULTS

According to Table 1. The mean value of depth of cure for near expiry PAM-C was 6.389 mm (± 0.202) and that of long expiry material PAM-C was 7.087 mm (± 0.149). The data suggest that PAM-C with long expiry has, on average, a depth of cure more than that of PAM-C with near expiry (Table 1).

The data provide strong evidence of a difference (0.698mm) between the means of near and long expiry PAM-C, the P value came out to be <0.001 (Table 1).

Table 1: Descriptive statistics of depth of cure of near and long expiry PAM-Cs

Expiry Status	N	Mean	Std. Deviation	P-value
Near Expiry	30	6.3890	20244	<0.0001
Long Expiry	30	7.0870	14972	<0.0001

DISCUSSION

In compomers, a number of factors are responsible for the adequacy of their polymerization process. Factors that are important are the type of filler used, the initiator /catalyst system and the most important is the type and amount of monomer used in the composition.[13]

This study evaluated the effect of shelf life on the adequacy of the polymerization process and its effect on the depth of cure of compomers.

The presence and post-cure release of residual monomers can have a negative impact on the biocompatibility of the material. In order to minimize these harmful effect halogen curing lights with a power density of atleast 250-300mW/cm^2 should be used.[14]

Polyacid modified composites like traditional composites have a limited depth of cure and their composition consists of additional monomers with acidic functional groups and degradable alumino-silicate glass particles.[15]

The depth of cure for compomers is controlled to a large extent on the opacity of the glass particles used. Thus the formulation of compomers plays an important role in determining the depth of cure, however literature states that lighter shades of compomers cure to a greater depth than do darker shades. In comparison with microfilled composites compomers cure to lesser depth depending on their shade.[16]

This study considered the effect of the shelf life on the depth of the cure of compomers with a specific formulation. It was observed that there is a significant difference in the depth of cure of the two chemically similar compomers. The compomer that had a long expiry date had a greater value of depth of cure than the compomer that had a short expiry date. It could be hypothesized that unexpired compomers had more amount of residual monomer in their matrix that matured over a period of time due to post cure, resulting in greater depth of cure. Whereas the compomer that had a short expiry date had less residual monomers, which resulted in lesser depth of cure. However no concrete correlation could be determined between the compomers with the different expiry dates and their depth of cure value. It must also be noted that light absorption and light scattering in resins reduces the degree of monomer to polymer conversion hence could have some effect on the depth of cure of the compomers with differing expiry dates.

Increasing curing lamp intensities and reducing the exposure time can also lead to an increase in the depth of cure of the compomers.[17]

Dunne has concluded in his study that depth of cure of resin is directly related to intensity of the curing light, duration of light exposure and inversely proportional to the distance of the light source.[18]

Depth of cure was also evaluated among different shades of resin composites and it was documented that shade A2 results in greater values of depth of cure than shade A4, the effect depending quantitatively on the formulation of the material. A layer of 2 mm is recommended to be applied in the incremental technique but in this study some formulations of PAM-Cs do not reach a depth of cure of 2 mm. Therefore a hard top surface of a PAM-C is not an indication of adequacy in depth of polymerization.[19,20]

CONCLUSION

The results observed in this study suggest that a greater depth of cure can be achieved with compomers having a long expiry as compared to compomers having a short expiry date. More experiments need to be carried out to find a relation between the value of depth of cure and expiry date.

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