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Archives of Dental Research

Journal homepage: https://www.adr.org.in/

Review Article

Preheated composite: Innovative approach for aesthetic restoration

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A R T I C L E I N F O

Article history:
Received 20-08-2021
Accepted 09-09-2021
Available online 31-12-2021

Keywords:
Preheated Composites
Microhardness
Temperature

A B S T R A C T

Resin-based composites are today one of the most widely used restorative materials. However, its most debilitating problem is volumetric shrinkage due to polymerization which may result in contraction stress and subsequent micro leakage and adhesion failure. Preheating composites prior to polymerisation have several advantages over conventional composites. This review article highlights the mechanical properties, advantages and significance of preheated composites.

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1. Introduction

Dental composites are replacing mercury-containing dental amalgam restorations as the restorative materials of choice. This is due to inherent esthetic appeal of the former and the long-standing controversy related to[1] the toxicity of the latter. Composites are mixture of two materials in which one of the materials, called the reinforcing phase, is in the form of fibers, sheets, or particles, and are embedded in the other materials called the matrix phase. Metal, ceramic, or polymer can be reinforcing material and the matrix material. Overall properties of the composites are superior to those of the individual[2] component and therefore composites are used. Increased popularity of composites rapidly in the first decade after being introduced is due to the fact that it provides with strength, abrasion resistance, ease of application, translucency, and polishability.[3,4]

1.1. Preheating composites

Polymerization shrinkage, postoperative sensitivity, inadequate proximal contact, poor wear resistance and lack of proper adaptation in some clinical conditions are conventional composite resins' drawbacks.[5] Friedman in 2001 introduced the concept of preheating composites.[6] Increment of restoration durability and stress relief[5–7], better adaptation[8] and shortening of curing time[9] are the benefits of preheating used to improve mechanical properties of composite resins. Daronch et al. reported that there is no significant difference between the preheated composite resins and composite resins.[10] Decreasing shelf life and requiring quick work are the drawbacks of composite preheating.[11] Also, one of the main concern is pulp compatibility when composite resins are preheated. Nevertheless, studies have found that rise in pulpal temperature only by 0.8°C after placement of a 60°C preheated composite resin while an increase of 5°C pulpal temperature is seen after 20s of light curing.[12] Daronch et al. found that after removing composites from heating device, 50% of the temperature attained will be lost after 2 minutes and almost 90% will be lost after 5 minutes.

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https://doi.org/10.18231/j.adr.2021.017
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1.2. Techniques to warm composites[13]

Different devices are avialable for chairside warming of composite.Eg. Calset composite warmer (AdDent, Inc., Dandury, CT, USA) is the most effective method to pre- heat composite resin. (Figure 1)

This device can heat material to 37°C, 54 °Cor 68°C and also maintain constant temperature

Clinical technique for pre-warming composite turn on the unit. The amber LED indicates normal function. Green LED flashes to indicate composite warming (10 minutes to reach 54C). Green LED shines steadily to indicate pre-set temperature. Heated compule is loaded into the syringe gun and applied directly to the tooth preparation.

- Light of dental unit chair can also be used clinically in order to warm composites. If you leave composite resin under the light of the unit chair, the temperature of composite resin will be raised.

1. Water bath to a specific preheating temperature
2. Commercially-available composite warmer
3. Calset Unit 21 composite warming unit
4. Laboratory oven at the specified temperatures for 30 min
5. Dry oven for 15 min
6. Incubator (with preheating temperature (23°C and 54°C) for 1 hr.

Fig. 1: Caslet composite warmer (Picture courtesy : Google)

1.3. Degree of conversion

Measuring hardness is considered as one of the indirect method to evaluate the conversion of carbon double bonds in resin composites. Trujillo et al.[14] stated that warming a composite resin within biologically compatible temperatures could improve the rate and conversion of polymerization. Additionally, a study conducted by Daronch et al.[15] concluded that the degree of conversion was significantly affected by preheating of both the top and bottom surfaces of the specimens, for all light-curing times. Reason behind this could be that an elevated composite temperature leads to increased molecular mobility. Therefore, longer time is taken by the propagation stage causing a diffusion controlled reaction. Furthermore, rise in the temperature below the glass transition enhances the mobility of the polymer chain, delaying the termination of the diffusion controlled reaction. By improving the monomer conversion, there is rise in the glass transition temperature, thus inducing a greater amount of conversion at higher polymerization temperatures. Arrhenius behaviour is seen with dimethacrylate-based systems, in which a large increase in the polymerization rate results due to small rise in temperature.[15]

Therefore, greater cross-linking and better mechanical properties can be achieved by improving the degree of conversion. Conversely, other studies[16–18] reported that microhardness was not affected by preheating resin composites. This different result might be attributed to the residual stresses which are generated due to elevated temperatures. Concentrated energy in the bulk of the material without the application of an external load is form of residual stress.

Chances of bonding failure increases and there is decrease in microhardness whenever the composite resin restoration experiences an occlusal load. Moreover, the methacrylate-based resin composites shows higher microhardness than that of silorane-based resin composites.[19] Silorane monomers contain silicon for compatibility and they also have an oxaspirocyclic core, which provides the possibility of doublering opening polymerization, resulting in volume expansion and decreased polymerization shrinkage of the composite.[19] Kusgoz et al.[20] concluded that the lower depth of cure of silorane-based composites in comparison to methacrylate-based composites might be due to this peculiar initiating system. Consequently, the reduced depth of cure of siloranebased composites is reflected in their reduced hardness.[18]

1.4. Microhardness

Improving the mechanical properties of resin composites by preheating is confirmed by Torres et al., Kashi et al., Eman et al. and Lucy et al.[21–24] On the contrary, a study conducted by Didron et al., concluded that preheating showed no significant effect on microhardness[25] found that preheating have. Shade and brand of the composite resin is also responsible for varied degree of conversion which explain the different findings of above- mentioned studies.

1.5. Flexure strength

Although, warming of composite resins increases degree of conversion, but it shows no effect on flexural strength. Salgado et al., Nada et al. and Uctasli et al. in their study have concluded that no significant difference in flexural strength between preheated and non-heated composites. Study conducted by Amario et al., reported that highly repeated cycles of composite preheating may have adverse effects on the flexural strength of resin composites.[26]

1.6. Microleage

Poor marginal adaptation and composite shrinkage are the reasons for micro leakage and consequently, results in recurrent caries, food retention and even restoration failure. Many attempts are made to limit shrinkage of composite resins and improve adaptation. In order to improve the adaptation researches had added fillers to resin composites. But, increasing the filler load resulted in higher viscosity which led to concerns about handling of the resin composite material and could leave behind unwanted void. Studies have shown that to improve adaptation and reduce microleakage lower viscosity composites can be used. In this regard, flowable composites were introduced which was achieved by decreasing the filler load. However, the flowable composites were not as durable and resistant as higher viscosity resin composites which restricted their application in restoration of posterior teeth.[26]

Preheating resin composite were introduced with a view to mimic flowable composites and achieve better adaptability by reducing viscosity, without losing its mechanical properties. The findings of Holmes et al., Wanger et al., Broome et al., Salgado et al. and Yang et al., Blalock et al. support preheating composites for decreasing microleakage of resin composite restorations.[26] Preheating of resin composites also leads to a more homogeneous polymerization and subsequently to a more homogeneous shrinkage and thus reduces the micro leakage.[25]

1.7. Colour stability

Study conducted by Mundim et al. concluded that there was no significant difference in color stability and opacity variation when temperature of resins were elevated. Staining of the silorane group was significantly higher than the methacrylate group. A study performed by Pires-de-Souza, also shows same findings, in which staining of the silorane composite after artificial aging process was higher than methacrylate composite resins. One of the factors responsible for such a finding is during the Artificial aging process causes separation of quartz particles from the resin matrix. This is one of the reasons responsible for such results. The curing temperature have a significant effect on the degree of composite resin conversion. Preheating of composite resins through enhancing radical mobility and a decrease in system viscosity influences polymerization and increases degree of conversion, affecting colour stability. The chemical stability is affected by conversion rate of the monomer. Non-converted dual carbon bonds renders the material disposed to bond destruction, reduced colour stability and releasing materials such as formaldehyde and meth acrylic acid. The polymer network is

Also, influenced by the solvents from the oral environment and destroys recently formed chains. Polymerization values have an impact on the stain susceptibility and colour statbility.[26]

1.8. Effect of temperature

In a study conducted by Walter, it was reported that approximately 50% of the increased temperature is lost by the warmed composites within 2 minutes after the composite is removed from the device and about 90% of increased temperature within 5 minutes. Placement of preheated composites into a cavity preparation could act as a heat sink, and also affects the rate of heat loss. Also, in a study by Daronch, it was argued that the resin be additionally heat soaked for a longer period to counter the cooling effect when the composite compule is removed from the heating unit. After removal from the heating unit the composites cools at a very rapid rate, therefore, time saving is essential in improving the performance of preheated composite.[27] Placement of the compule directly into the delivery syringe during compule preheating seems more beneficial than preheating only the individual compule itself. Impact of preheated composite on the pulp is of concern.

According to Maeda et al., the intraoral physiologic temperature range in humans is from 34.2°C to 36.6°C. Other studies reported that 41.5°C is the critical temperature limit for pulpal fibroblast.[27] According to Trujillo et al., temperature rises of greater than about 5°C from the baseline level of approximately 32–34°C could potentially compromise the vitality of pulp.[14] Contrary to the concern, it has been reported that in clinical situations due to time delay between dispensing it from the syringe and placing it into the preparation, a significant decrease in temperature occurs. Daronch et al. found no significant differences in the intrapulpal temperature between room temperature and preheated resin composite at similar restorative stages. In another study, Daronch et al. concluded that the temperature of resin composite decreases rapidly when the compule is removed from the heating device.15 It was observed that preheated composites upto 54.5°C were placed inside the cavity, the temperature rise recorded by a thermocouple situated in the pulp chamber was only 2.4 ± 0.3°C. Such a temperature rise is relatively safe.[14]

1.9. Clinical Significance

1. Improvement in the conversion rate, as well as in the fracture resistance of the material and a reduction in curing time by 50% or more can be achieved by pre-warming restorative composite.
2. When composite are pre-warmed to at least body temperature it provides an advantage of a better restoration with improved physical properties, both in the short and the long term.

1.10. Advantges

Preheating composite resin make them more durable, highly filled, highly viscous conventional composite resin. Reduced viscosity, to provide flow values that are similar to those of less filled, flowable composite resins, without undermining the mechanical properties is achieved. An additional advantage is increased monomer conversion and polymerization rate by heating the resin prior to placement.[28]

2. Conclusion

It is concluded that degree of conversion, viscosity, microleakage, marginal adaptation, microhardness and color change are positively affected by preheating of composite resins. However, further more clinical studies are required.

3. Source of Funding

None.

4. Conflict of Interest

None.

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Cite this article: Asani RN, Gade VJ, Umale KG, Gawande R, Amburle RR, Kusumbe RR, Kale PP, Kosare PR. Preheated composite: Innovative approach for aesthetic restoration. *Arch Dent Res* 2021;11(2):103-107.