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Effect of preheating on various properties of resin composite. A review article

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ABSTRACT

The frequency of posterior resin composite restorations is increasing due to their aesthetic appeal and conservative nature. However, a balance between material properties and application techniques is crucial for successful restorations. High viscosity resin composites can improve properties but can also cause gaps and microleakage. Preheating resin composites is a technique used to improve flowability, reduce film thickness, and optimize polymerization, but its impact on mechanical properties and clinical performance remains unclear.

Conclusion:

Preheating resin composites enhances flowability and minimizes gaps formation, but further randomized clinical studies are needed to fully comprehend its applications and limitations in clinical practice.

Keywords: *Composite preheating or composite warming or Thermoviscous,modified USPHS criteria ,bulkfill resin composite, posterior restorations, posterior composite*

1. Introduction

The increase in the frequency of posterior resin composite restorations can be attributed to the material's esthetic appearance and conservative nature, as well as advancements in their physico-mechanical properties. The complete adaptation between the resin composite restoration and the tooth structure is a typical concern with resin composite. The development of gaps between the restoration and tooth might lead to issues including recurrent caries and postoperative sensitivity.

Resin composite restorations success depends mainly on physical and mechanical properties, including polymerization shrinkage, viscosity, packing capacity, and bonding ability. While increasing the filler content of high viscosity resin composite can improve their physical, mechanical properties and material packing ability, it can also make it very difficult to adapt the restorative material to the cavity walls, leading to the formation of interfacial gaps and increased microleakage formation. These challenges highlight the importance of balance between material physical, mechanical properties and application techniques to achieve successful resin composite restorations. Careful consideration of the specific clinical scenario and selection of appropriate materials and techniques are essential for achieving optimal outcomes and long-term success rate in posterior resin composite restorations [(1)].

Preheating resin composite is a widely used technique to enhance flowability, reduce film thickness, increase degree of monomer conversion, optimize polymerization, and increase surface hardness. However, the impact of preheating on other mechanical properties and clinical performance remains to unclear [(2)].

Preheating of resin composite:

Preheating resin composite has been associated with several clinical advantages. Preheating, particularly for high-viscosity resin composites, improves the material's flowability and lowers its viscosity, allowing for better adaptability to cavity walls. By decreasing microleakage, preheating the resin composite increases the restoration's lifespan. Because preheating increases the mobility of radicals and monomers, which raises the degree of monomer conversion and improves degree of polymerization [(3)]. These include enhanced mechanical characteristics, improved restoration longevity, stress reduction, superior adaptability, and faster curing time. However, conflicting findings have emerged in the literature.

While some studies support the benefits of preheating, no significant variation between preheated and non-preheated resin composites Additionally, there are drawbacks to resin composite preheating. It has been noted that preheating reduces shelf life and necessitates expedited procedures. Concerns regarding pulpal irritability arise when composite resins are heated to temperatures ranging from 55-69°C. Despite these concerns, experiments have indicated minimal impact on pulp temperature, with a study showing that placing a composite resin warmed to 60°C raised pulp temperature by only 0.8°C, whereas 15 seconds of light-curing raised pulp temperature by 4.5-5°C [(4)].Furthermore, the practical aspects of preheating should be considered. Some literature reported that after removing resin composites from the external warming device, 50% of the achieved temperature is lost within 120 seconds, with approximately 90% lost within 300 seconds. This highlights the transient nature of the temperature increase achieved through preheating. These findings underscore the complex considerations involved in the use of preheating for composite resins. Engaging with the existing body of research can aid clinicians in making informed decisions about whether and how to implement preheating in dental practice, taking into account both the potential benefits and limitations associated with this technique.[(5)]

Effect of preheating on Microhardness:

The effect of preheating temperature on the microhardness of four different resin composite materials, was investigated by **(Ayub et al., 2014)** [6] . Samples of tested resin composite materials were divided into two groups, with ten samples in each group. In group one, the resin composite materials were placed into the molds at room temperature and allowed to be light cured. In group two, the materials were preheated using a heating device then placed into the molds, and allowed to be light cured. Following light curing, microhardness tests were carried out utilizing a 300 g load applied for 10 seconds, both immediately after light curing and after storage for 24 hours storage. On both the top and bottom surfaces of each sample, five randomly chosen spots were used to calculate the average microhardness. The results indicated that preheating of the resin composites increased the microhardness and decreased the viscosity of the samples. The researchers concluded that the effects of preheating resin composites allowed easier placement of restorations and greater monomer conversion. Overall, the findings suggest that preheating the resin composites before insertion and curing can influence their microhardness, potentially improving their performance in application technique.

(Jafarzadeh-Kashi et al., 2015)[7] conducted an invitro study to assess the effect of three different preheating temperatures on the microhardness of three different nanohybrid resin composite materials. The degree of conversion obtained by polymerization significantly affects the physical and mechanical properties of resin composites, and microhardness testing can provide an indirect method to evaluate the degree of monomer conversion. The study involved thirty specimens for each commercial resin composite, including Grandio (Voco), Simile (Pentron), and Tetric N-Ceram (Ivoclar Vivadent). These specimens were randomly subdivided into three subgroups, Subgroup one was preheated at room temperature 21°C, subgroup two was preheated at 37°C, and subgroup three was preheated at 54°C. After the preheating process, the specimens were photopolymerized for 20 seconds. The results revealed that the microhardness values in the Grandio resin composite group were significantly different between all three subgroups. In the Simile resin composite group, the only significant difference was between 21°C and 54°C. In the Tetric N-Ceram resin composite group, the differences between 21°C and 54°C and between 21°C and 37°C were considered statistically significant. The study concluded that regardless of the resin composite material brand used, surface hardness was considerably improved by increasing temperature. Furthermore, the microhardness values were significantly influenced by the brand of resin composite. Therefore, preheating temperature had a notable effect on the microhardness of the resin composites, and the choice of resin composite brand played a significant role in determining the microhardness values.

(Elkaffass et al., 2020)[8] evaluated the effects of preheating on the surface roughness, fracture toughness, and microhardness of the nanofilled resin composite in an in vitro study. True nano Filtek Z350 XT resin composite, was used. Two groups of samples were light-cured the non-preheated group was light-cured at room temperature (24° C), while the preheated group was light-cured after preheating. There were fourteen samples in each group. Using an atomic force microscope, surface roughness measurements (Ra) were taken on. A universal testing machine was used to test the specimens in three-point bending mode at a crosshead speed of 1.0 mm/min until failure was observed. Results indicated no significant difference between the non-heated and preheated groups could be found in any of the independent sample. However, for the Vickers hardness test, the top and bottom surfaces for the non-heated and pre-heated groups significantly differed (p 0.05). Additionally, although the preheated group's mean values for surface roughness, Ra (nm), were higher than those of the non-heated group, there was no discernible difference between the two. Conclusions: Because preheating did not adversely affect the nanofilled resin composites' microhardness, fracture toughness, or surface roughness, preheating is advised for any additional potential clinical benefits.

(Yu, Liu et al. 2023)[9] used an intraoral scanner to measure pit-and-fissure caries of varying widths and evaluated the effects of preheating on the surface hardness and microleakage of resin composite. Prior to adding various resins (room temperature Z350 flowable resin composite, room temperature Z350 universal resin, and 60 °C Z350 resin composite), the cavities were measured in three dimensions using a TRIOS scanner. Microleakage and gap development were evaluated at two places using stereomicroscopy and a scanning electron microscope. Following preparation, all resin samples were assessed for their top surface Vickers hardness (VHNtop) at one day and 30 days post irradiation. Results showed that groups with the same width showed no differences in the sizes of the cavities in the 3D scans. The flowable group had the lowest microleakage for the 1 mm wide cavity; the nonpreheating universal group had the highest microleakage at site 1 for the 1.6 mm-wide cavity; the preheating group had a lower microleakage than the nonpreheating universal group at site 2 for the 2 mm-wide cavities; and the flowable group had the lowest microleakage at site 1 for the 1.6 mm-wide cavity. The gap formations and the levels of microleakage were consistent. At 1 day and 30 days post-irradiation, the preheating group showed the highest VHNtop.They came to the conclusion that the cavities could be scanned in three dimensions using a digital intraoral scanner. The surface hardness and microleakage of Z350 universal resin composite could both be improved by preheating technology.

Effect of preheating on polymerization shrinkage:

(Tauböck et al., 2015) [10] conducted this study to look at how preheating of high-viscosity bulk fill resin composite materials affects the development of shrinkage stresses and the degree of conversion. One conventional nanohybrid resin composite materials (Tetric EvoCeram-TEC) and four bulk fill resin composite materials (x-tra fil-XF, QuixFil-QF, and SonicFill-SF) were used. The tested materials were either kept at ambient temperature or preheated using a commercial heating equipment to 68°C before being light cured for 20 seconds using an LED curing machine. The results showed that whereas resin composite preheating had no influence on the monomer conversion of the other materials examined, it dramatically boosted the degree of conversion of TECBF. For every test material, preheated resin composites produced noticeably less shrinkage stresses than room temperature resin composites. Furthermore, at both temperature levels, TECBF produced the most shrinkage stresses, while QF produced far larger shrinkage stresses than both XF and TEC. The investigation found that shrinkage stresses creation was impacted by the preheated temperature as well as the resin composite material. Bulk fill resin composite and traditional restorative nano-hybrid resin composites were preheated before photoactivation to reduce shrinkage stresses without decreasing conversion degree. The results have clinical value because they show that, depending on the particular resin composite material employed, preheating can decrease shrinkage stresses generation of traditional resin composites and high viscosity bulk fill resin composite while preserving or even increasing the degree of monomer conversion. Dental professionals should take note of this discovery as they work to maximize the efficacy of resin composite materials during restorative operations.

(Dionysopoulos et al., 2016)[11] conducted an in vitro study to assess the impact of preheating on polymerization. Using four highly viscous bulk fill resin composite, four bulk fill flowable resin composite a traditional nanohybrid resin composite used as the control. Vickers hardness measurements were performed on five specimens of each material. The findings demonstrated that microhardness values decreased with depth. The microhardness of the resin composite materials increased when preheated at 54°C compared to the specimens at room temperature. They came to the conclusion that preheating temperature and post-irradiation polymerization increase the polymerization efficiency of bulk fill resin composites, which is influenced by their chemical composition**.**

In study by **(Theobaldo et al., 2017)**[12] the impact of resin composite preheating and polymerization mode on the degree of conversion (DC), microhardness (KHN), plasticization (P), and depth of polymerization (DP) of a bulk fill resin composite were tested. They prepared 40-disc shaped samples of a bulk fill resin composite, which were then divided into different groups based on the light-curing unit used and the preheating temperature. The researchers assessed the DC using a Fourier transform infrared spectrometer, measured KHN with a Knoop indenter, evaluated P by assessing the reduction in hardness after 24 hours ethanol storage, and determined DP using a bottom to top ratio. Their findings revealed that higher preheating temperatures increased DC on the bottom surface, and the use of a light-emitting diode (LED) resulted in a higher DC compared to a quartz–tungsten–halogen (QTH) light curing unit. Additionally, the study observed that KHN, P, and DP were not affected by curing mode and preheated temperature, and the flowable resin composite showed similar KHN but lower DC and P compared to the bulk fill resin composite. In conclusion, the preheating increased the polymerization degree of bulk fill resin composite but led to higher plasticization compared to the conventional flowable resin composite materials evaluated.

The impact of preheating bulk-fill BIS-GMA free and containing resin composite on post-gel shrinkage strain was examined in a research by **(Lotfy et al., 2022)** [13]**.** They made sixty resin composite specimens and used strain gauges to track the post-gel shrinkage strain for three minutes following light irradiation. Depending on the temperatures that were chosen, the specimens were split into three groups: room temperature (23°C), 50°C, and 65°C. According to the investigation, at the three different temperatures, Viscalor thermoviscous bulk fill resin composite had the lowest values of polymerization shrinkage strain. Depending on the material employed at each temperature, there was a statistically significant difference between the groups; when warmed at 65°C, both tested materials had the largest shrinkage strain. The results showed that thermoviscous technology was introduced to decrease polymerization shrinkage stresses by providing a flowable resin composite's viscosity, but in reality, it had the opposite effect. The bulk fill BIS-GMA free resin composite did not experience a decrease in polymerization shrinkage stresses when it was preheated to 50°C or 65°C. Furthermore, it was discovered that the bulk-fill BIS-GMA containing resin composite, both with and without preheating, had a considerably higher polymerization shrinkage steresses than the BIS-GMA free resin composite.

Effect of preheating on microtensile bond strength to dentin:

The impact of warming nanohybrid and bulk fill resin composites with a warm airstream on their microtensile bond strength (MTBS) to dentin was investigated by **(Boruziniat et al., 2023)** [14] . Dentin from forty-two extracted premolars was used in this in study. EverX posterior bulk fill resin composite and Grandio nanohybrid resin composite were used in this research. The teeth were split into two groups, each with three subgroups: one for heating the resin composite to 50°C using a commercial warmer device; another for using a hair dryer to create a warm airstream for 10 seconds; and a third group for not heating the resin composite. Using an incremental layering approach resin composite cylinders were packed to the tooth surface and then cured. Using a stereomicroscope and a scanning electron microscope (SEM), the MTBS to dentin was measured and the bonding contact was assessed. The findings demonstrated that the mean MTBS of the warm airstream subgroup in both composite groups were much greater than that of the warmer and control subgroups. Furthermore, the warmer subgroup's mean MTBS was considerably lower than the control subgroups. Additionally, only in the warmer group did the MTBS of the EverX posterior resin composite considerably exceed that of the Grandio resin composite. In both groups, adhesive failure was more common; for all types of resin composites, the airstream subgroup had the highest incidence. Finally, the MTBS of both resin composite types to dentin was greatly boosted by preheating with a warm airstream. These findings underscore the potential benefits of preheating resin composite materials with a warm airstream in enhancing their bond strength to dentin.

To determine the effect of preheating resin composite preheating on the microtensile bond strength to dentin **(Hanafy et al., 2024)** [15] carried out an in vitro study. Thirty-two human molars teeth were used in the investigation. Molar teeth were divided into two groups according to the kind of resin composites used microhybrid (P60) or nanohybrid (Z250 XT) resin composite materials. Resin composite restorations was further divided into four subgroups according to number of cycles for preheating. The results demonstrated that the kind of resin composite and the number of preheating cycles had a statistically significant impact on the microtensile bond strength between resin composite materials and dentin. The results of the investigation indicate that Filtek P60, a packable resin composite, may achieve notably higher microtensile bond strength than Filtek Z250 a microhybrid resin composite when preheated to 68°C. They concluded that preheating resin composite materials might significantly affect the microtensile bond strength between dentin and restoration, which may have consequences for bonding process optimization.

The clinical performance of preheated resin composite:

(Elkaffas et al., 2022)[16] used a split-mouth, double-blind, randomized design to examine the impact of preheating resin composites on the clinical performance of class I restorations over the course of a 36-month period. The selection process involved 35 patients in total. Every patient received a set of posterior restorations made of class I nanofilled resin composites (RC, Filtek Z350 XT). Following the manufacturer's instructions, preheated resin composites were placed on one side of the mouth while nonheated composites were placed on the opposite side. The FDI World Dental Federation criteria were used to evaluate these restorations at one week (baseline), twelve months, twenty-four months, and thirty-six months. They examined that 66 restorations were examined, and 33 patients showed up for the recall visits after 36 months.At 36 months, a significant difference was found for staining as a criterion. When the baseline and 36 months in the nonheated resin composite group were compared, a significant difference in the staining was also found. The nonheated resin composite demonstrated 93.9%, 100%, and 100% of the clinically accepted scores, respectively, for esthetic, functional, and biological properties, while the preheated group displayed 100% for all properties. Although postoperative sensitivity was present in four restorations for nonheated restorations (11.4%) and five for heated restorations (14.2%) at baseline, the postoperative sensitivity scores were deemed highly acceptable at 12,24, and 36 months. They concluded that preheated nanofilled resin composites in class I restorations demonstrated acceptable clinical performance after 36 months that was comparable to that of the nonheated ones, but with improved resistance to marginal staining.

In investigation, by **(Taufin et al., 2022)**[17] the impact of Ceram-X-Mono, a preheated nanoceramic resin-based composite (RBC), was to be assessed over the course of 18 months in Class I occlusal cavities. A randomized controlled clinical trial (RCT) with a split-mouth design is used in this study. 24 patients had 24 Class I occlusal cavities restored by one operator. 30 prepared cavities were filled with nanoceramic RBC that had been preheated to 60°C for 10 minutes, as opposed to 30 restorations in the unheated group that were installed in accordance with the manufacturer's instructions. At baseline, 6, 12, and 18 months after the restorations were completed, two observers evaluated them using Federation Denttaire Internationale (FDI) standards. Results showed 100% retention rates were observed in both groups. Surface staining, color stability, anatomical form, and marginal adaptation were all significantly different in the nonpreheated group, whereas surface staining significantly increased in the preheated group. For the tested clinical parameters, there was a statistically significant difference between the preheated and nonpreheated groups at various time intervals.so they concluded that preheated nanoceramic RBC restorations demonstrated superior clinical performance in this RCT's 18-month time frame compared to the nonpreheated group.

A randomized clinical trial was carried out by **(Favoreto et al., 2023)** [18] to determine which method using a Caps dispenser along with a Caps Warmer (CD) or a VisCalor Caps dispenser/warmer (VD) is the most effective for preheating resin composite restorations in non-carious cervical lesions (NCCLs). One hundred twenty restorations were divided into two groups in accordance to the thermoviscous bulk fill resin composite CD group's preheating method. Preheating was done at 68 °C for three minutes using a heating bench. Preheating was done with a heating device at 68 °C for the VD group. The bulk fill resin composites were then put directly into the NCCLs after being preheated. The duration of the workday was noted. According to the FDI criteria, the restorations' clinical performance after 12 months was evaluated. The findings demonstrated that VD had a shorter working time than CD, with a statistically significant difference. After 12 clinical evaluations, few restorations were lost or fractured. In terms of retention, CD had a rate of 96.7% and VD had a rate of 98.3%. They came to the conclusion that after a year, there was no difference in the clinical efficacy of thermoviscous bulk fill resin composite restorations in NCCLs between the different preheating techniques.

The clinical performance of bulk fill resin composite materials with different viscosities in posterior proximal cavities was assessed by **(Goda et al., 2024**[)] [19] .The study employed four different bulk fill resin composite materials (SonicFill3, FiltekTM Bulk Fill, preheated FiltekTM Bulk Fill, and G-aenialTM Bulk Injectable). Fifty patients had a total of eighty posterior proximal restorations accomplished. Using a double-blind, randomized clinical trial approach for two years follow up using modified FDI criteria. The results of the investigation demonstrated that all 80 restorations were available for evaluation with a 100% survival function. There were no statistically significant differences seen when comparing the four groups' aesthetic, functional, and biological attributes at different follow up intervals. The results indicated that the bulk fill composite materials with various viscosities showed good clinical performance in proximal posterior cavities and seemed to be aesthetically, functionally, and physiologically acceptable after two years of clinical follow up.

Effect of preheating on other properties:

(Campbell et al., 2017) [(20)] conducted a randomized controlled clinical trial to determine postoperative sensitivity using preheated and room temperature resin composite. Resin composite restorations were placed in group one at room temperature and in group two after preheated to 39°C. They discovered that there was no detectable difference in postoperative sensitivity between resin composite restorations that had been preheated and those that had not. They concluded that when teeth are restored with resin composite, there is no discernible difference in postoperative sensitivity between preheated and room temperature resin composite restorations.

In an in vitro study, **(Metalwala et al., 2018)**[(21)] examined the rheological properties of four nanohybrid resin composites. Three different preheating temperatures (25, 37, and 60 °C) were used. Results showed that flowability of the nanohybrid resin composites was significantly enhanced by preheating, which may help in clinical placement and adaption. They concluded that heating the nanohybrid resin composites considerably improves their flowability, which strengthens the seal and improves mechanical properties.

In a study by **(Chaharom et al., 2020)** [(22)] examined the effect of preheating of bulk fill resin composite on material cytotoxicity . Three different types of resin composite (Xtrafil, Xtrabase, and Tetric N-Ceram Bulk Fill) were used. Ten cylindrical samples were made from each resin composite materials, five of the samples were warmed to 68°C, and the other five were polymerized at ambient temperature (25°C). After 24 hours polymerization, human fibroblasts were used in the MTT experiment to measure cytotoxicity. The results showed that the mean percentage of cytotoxicity in terms of preheating did not change statistically significantly. Nevertheless, there was a significant difference in the cytotoxicity of the examined resin composite materials, with Tetric N-Ceram Bulk fill resin composite having a greater cytotoxicity than the other two materials. The study concluded that preheating of bulk fill resin composite did not affect their cytotoxicity. Additionally, it was observed that the cytotoxicity of different bulk fill resin composite was not the same. This research provides valuable insights into the effects of preheating on resin composite cytotoxicity and highlights the differences in cytotoxicity among various bulk fill resin composites brands. These findings may have implications for dental practitioners in choosing appropriate resin composite materials for restorative procedures while considering their cytotoxic effects.

The impact of preheating resin composite on the development of marginal gaps in Class II (CL II) restorations was examined by **(Darabi et al., 2020)** [(1)] . In this in vitro study, the mesial and distal surfaces of 30 extracted premolar teeth had sixty (CL II) cavities prepared. Cavities' gingival floors were positioned 1 m below the CEJ. For the purpose of placing the samples for restoration, the samples were divided into four main groups. Group one, Filtek P60 at room temperature; group two, Filtek P60 at 68°C; group three, X-tra fil at room temperature; and group four, X-tra fil at 68°C.The teeth were divided longitudinally in a buccolingual direction after thermocycling. Then, using a scanning electron microscope at a magnification of 2000 times in micrometers, the marginal gaps of the samples were measured at their proximal and gingival margins. Results showed that when compared to groups one and three, groups two and four had significantly smaller marginal gaps at both the enamel and dentinal walls. In comparison to composite dentin wall interfaces, there were significantly fewer marginal gaps in all groups at composite enamel wall interfaces. Enamel walls and dentinal walls did not significantly differ between groups one and three and groups two. They came to a conclusion in both resin composites, preheating led to a reduction in marginal gaps. On marginal adaptation, the type of resin composite had no effect.

Using micro-computed tomography (μCT), **(Demirel et al., 2021) [(23)] e**xamined the impact of three distinct insertion procedures on internal void development in bulk-fill resin composites. Four different bulk fill resin composite types, a traditional posterior resin composite, and a control group consisting of a hybrid CAD/CAM block were tested. Standardized cylindrical cavities were made in 160 human third molars, and resin composite restorations. Based on each kind of resin composite and insertion technique were built (n=10). Preheated, sonic fill, and traditional were the three available resin composite placement techniques. All resin composites, with the exception of SonicFill 2, had the highest void rates when the sonic delivery method was used. Placement techniques of resin composite materials had no effect on this. The results showed that, in comparison to traditional and sonic delivery methods, preheating could be a more useful technique for decreasing internal void in bulk fill resin composites.

In a study by **(Kincses et al., 2021) [(24)]** two bulk fill resin composite materials temperature changes during application polymerization, degree of conversion (DC), and unreacted monomer elution at room temperature (RT) and after preheating were investigated : Filtek One Bulk (FOB) and VisCalor Bulk (VCB). While the sample was being processed, the temperature was monitored using a K-type thermocouple thermometer. The amounts of BisGMA, UDMA, DDMA, and TEGDMA were measured, and the DC at the top and bottom surfaces, using High-Performance Liquid Chromatography (HPLC). During insertion, the temperature of the preheated resin composite rapidly decreased, and the study found that the elevation in temperature during polymerization correlated with the lower DCs. The DC ratio between the top and bottom varied noticeably. When compared to (FOB), (RT)VCB's DC ratio was lower. With the exception of the bottom surface of the FOB, where a notable drop was seen, pre-heating had no effect on the DC. Pre-heating showed little influence on monomer release from VCB, with the exception of TEGDMA, whose elution was lowered. However, it dramatically reduced the elution of BisGMA, UDMA, and DDMA in the case of FOB. The study found that pre-cure preheating temperature had less of an impact on DC and monomer elution than did the makeup of resin composite materials.

Research was done by **(Dunavári et al., 2022) [(25)]** in order to measure the closed porosity (CP) volume as well as the monomer elution (ME) from resin composites that were both at room temperature and pre-heated. Layered conventional resin composite samples and samples of bulk-filled resin composites were created. Temperatures of 24 °C and 55 °C or higher were chosen for the pre-polymerization phase. Using standard monomers, high-performance liquid chromatography was used to evaluate the ME in RBC sample. Micro-CT imaging was used to measure CP. Because of pre-heating, ME significantly increased from layered samples while it significantly decreased from bulk fills. In most RBCs, pre-heating had a negative effect on CP. They concluded that pre-heating high-viscosity bulk-fill resin composites improve biocompatibility, which is good from a clinical perspective, but it increases CP, which is bad from a mechanical perspective.

Conclusion:

Preheating of resin composites increase flowability and decrease marginal gaps. In order to completely understand preheating's applications and limitations in clinical practice, more randomized clinical studies should examine how it impacts composite resin materials in general.

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Disclosure
The author reports no conflicts of interest in this work.

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