



Bond Strength Level of Preheated Composite Used as a Cement in Indirect Adhesive Restoration

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Abstract

Introduction: Heating composite resins can reduce viscosity properties, increase adaptation to cavity walls, and facilitate application. There is still a lot of debate about the degree of microleakage and bond strength in preheated composites to determine how strong these composites are as cementation materials. **Purpose:** To analyze the strength level of preheated composite as cementation material in indirect adhesive restoration in terms of microleakage rate and bond strength. **Methods:** Preheating composite can reduce the viscosity of the composite to facilitate the placement of the composite and obtain better adaptation to the cavity wall. By analyzing the relevant references, the strength of the preheated composite material will be investigated by looking at the level of microleakage and the level of bonding between surfaces. **Conclusion:** Heating the composite to an appropriate temperature (50°C) can reduce microleakage and increase the micro-shear bond strength in the exposed dentin.

Keywords: Cementation; Preheated composites; Preheated composites strength

Introduction

Aesthetic dentistry has become necessary, along with the increasing demand for tooth bleaching (77.8%) and veneers (54.8%).¹ The use of composite resins and adhesive systems are also extensively used for aesthetic tooth restorations. Dental rehabilitation using indirect techniques was developed to solve some problems associated with direct techniques, such as polymerization shrinkage and tend to get worn easily. For this reason, indirect composite restorations are now a significant part of contemporary aesthetic restorative treatment.²

The use of preheated composites as a cementation of indirect restorations was first introduced by Friedman.³ Preheated composites can be performed by placing a compule or syringe filled with composite material in a composite heating tray or water bath.⁴ Heating composite resin (preheated composite) can reduce the viscosity properties of the composite because higher heat energy allows molecular



motion to occur. This movement facilitates the placement of the composite and results in better adaptation to the cavity wall.⁵



The application of preheated composites still has to be evaluated regarding their bond strength level. This literature review will discuss the strength of the preheated composite material by the level of microleakage and the level of bonding between surfaces.

Discussion

Dental restoration is the process of restoring the function, integrity, and morphology of the lost tooth structure with dental restorative materials. Based on ADA (American Dental Association), restorative materials are categorized into two groups, direct and indirect. When direct restoration is not possible then it requires preparation of the restoration outside the oral cavity. Such restorations are known as indirect restorations.⁶⁻⁸

Indirect adhesive restorations have been defined as partial crown restorations fabricated in composite or all-ceramic, which must be passively seated, and cemented adhesively in a specified cavity. The indication of indirect adhesive restorations are: (1) rehabilitation of caries teeth, (2) aesthetic correction of dental anomalies (shape, position, dimension, color), (3) ceramic or metal cementation materials, (4) cementation of crowns or bridges, (5) splinting, (6) repair of cracked restorations.^{9,10}

Dental cement serves as a luting agent to fill the gap between the restoration and the tooth structure. This cement will flow between the two materials and then harden, which provides mechanical retention for the restoration. Another function of cement is as a filling material that is used for permanent or temporary restorations. Also, as a base for other restorative materials, such as composite.¹¹

Preheated composite resin is a thermoplastic technique, which reduces the viscosity of conventional composites when heated because of increased molecular agitation. It provides adequate viscosity for indirect restorations to get fixated. Thus, this preheated composite can be used as an adhesive agent but still provide sufficient mechanical strength properties.¹²

Several studies have suggested a preheating device, the Calset Composite



Warmer, to make a highly filled composite less viscous. The benefits of preheating composites are: (1) allowing the material to have a better adaptation to the cavity wall, (2) reducing the potential for air trapping, and (3) improving the physical and mechanical properties of the final restoration.¹³

The following tests are used to determine the bond strength of preheated composite resin

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1. Micro Leakage Test

The thermocycling process was carried out on the teeth for 500 cycles at a temperature of 5°C – 55°C within 30 seconds. The teeth were immersed in fuchsin alkaline solution for 24 hours to check for microleakages between the surface of the composite resin and the teeth. Then, a diamond disc was used to cut the teeth longitudinally. The presence or absence of microleakages is assessed visually by using a confocal microscope by measuring the amount of dye penetration along the boundary of the composite resin with the tooth.¹⁴

2. Micro-tensile Bond Strength (MBS) Test

Restorations cemented with preheated composite were cut transversely into 1.5 mm discs for attachment to a micro-tensile device (TA. XT Plus C; Stable Micro System), which was used to evaluate restorations. The parameter used was a speed of 3 mm/sec with a tensile force of 5 g to evaluate the tensile bond strength of the micro.¹⁵

3. Test of Microshear Bond Strength (MSBS)

The measurement of MSBS was done by using a Universal Testing Machine (Zwick 1445, Zwick, Ulm, Germany). The specimen was positioned in the sample holder of the test machine with the dentinal surface parallel to the chisel-shaped loaded piston. A shear load was applied to the adhesive interface at 1 mm/min speed until debonding or loss of bond occurred. The load during debonding was recorded and the MSBS value (σ) was calculated.¹⁶

A. Microleakage Rate

Deb et al. (2011), states that preheated composites can increase the flow and conversion rate of composites but different materials showed a variety of results in the flow rate. The increased flowability does not reduce the incidence of microleakage but due to the improved flow, the increased shrinkage may have been offset by the better edge adaptation of the composite. Thus, the use of preheating composites showed no significant difference in microleakage compared to



composites at room temperature.⁵

However, it contradicts the research by Yang, et al. (2016). This study was conducted to find out the effect of temperature in composite resin restorations on the level of microleakage. The results of this study indicate that the preheated treatment at 50°C has the optimum restoration interface with minimal or no microleakage compared to the preheated treatment at 60°C and room temperature. A similar result was also reported by Nivea et al., (2010), which stated that preheated composite show better edge adaptation compared to composite at room temperature. The decreased viscosity of the composite when heated leads to the better adaptability of the composite to the cavity wall. Thermal vibration causes the composite monomer to move further hence it slides more easily.^{14,17}

The research by Baroudi and Mahmoud (2015) states that microleakage which is affected by preheated is discussed from two different points of view. The first viewpoint correlates preheated composites with reduced microleakage in Class II composite restorations, which is supported by Wagner et al. (2008) and Aksu et al. (2004). Another point of view is put forward by Karaarslan et al. (2012) who tested microleakage on preheated composites and found no significant difference with the preheated composite group.^{18,19}

Another view is also expressed by Santos, et al. (2011). His research states that the group heated to 54°C showed better outcomes than the room temperature group. However, his research deals with the use of different light-cure units. The preheated composite does not reduce microleakage for the light-cured group using the LED unit. Preheated composites are more effective in reducing microleakage for the light-cured group using the QTH unit.²⁰

B. Micro Tensile Bond Strength

Alvarado, et al. (2020) did a study to evaluate the effect of indirect restorations of composites cemented with preheated composites on the marginal sealing, adhesive interface, and micro-tensile bond strength. As a result, there was a close



union between dentin and composite in restorations cemented with preheated composites, but the value of micro-tensile bond strength was lower in restorations cemented with preheated composites (144.49 N/cm³) and higher in those cemented with composites (278.75 N/cm³), with a statistically significant difference between the two groups.¹⁵

El-Deeb, et al. (2015), also did a similar study using a scanning electron microscope (SEM). As a result, there was no significant difference between the MBS scores of all test groups. SEM revealed mixed failure. Preheated composites were shown to increase the intra-pulp temperature (IPT) but not to a critical level and did not affect dentinal MBS.²¹

Nada and El-Mowafy (2011) investigated the effect of heating before polymerization on the mechanical properties of composites. The results of this study indicate that the diametrical tensile strength increases with heating before polymerization, but the difference is statistically significant in only one material. Different brands of composites with different temperatures can produce different mechanical properties.²²

C. Micro-shear Bond Strength

Research on the micro-shear tensile bond strength test was conducted by Kramer, et al. (2016). The composite material at certain temperatures (25°C, 37°C, 54°C, 68°C) was applied to the teeth. The results of his research stated that the preheated composite did not show any significant difference, either in the bond with dentin or in the bond with ceramics. The high temperature gave a good impact on the adhesion working system but only in one MSBS test group.¹⁶

A similar study was conducted by Demirbuga, et al. (2016) by determining the effect of preheating on the micro-shear bond strength (MSBS) of composite resin to dentin. The result of their study revealed the highest value of MSBS in the heated group while the lowest in the group cooled to 4°C. Their study concluded that preheating the composite resin can be an alternative to increase the MSBS of composites on dentin.²³



Tomaselli, et al. (2019) also conducted a similar study to test the shear bond strength of preheated composites. As a result, all composites exhibited the same micro-shear bond strength. The shear bond strength of the composites on the enamel is not affected by the preheating of conventional composites. However, this study used enamel as a substrate because it is more homogeneous than dentin and also it allows to test the bond strength after passing light through the ceramic veneer material.¹²

Conclusion

Microleakage of the composite can be reduced by heating the material at a temperature of 50°C. In terms of bond strength (MBS), preheated composites did not cause significant improvement compared to unheated composites. In terms of the micro-shear bond strength (MSBS), the study showed a higher bond value in preheated composites. Many studies still show some different outcomes, which may happen because of the differences in the method such as using a different type of composite, temperature values, and the length of the application process to the cavity so further research is still needed with the generalization of the test methods and materials being tested.

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