B-Dent: Jurnal Kedokteran Gigi Universitas Baiturrahmah, Vol 9, No. 1: page 107-114
ISSN 2301-5454, e-ISSN 2654-7643
Available online at https://jurnal.unbrah.ac.id/index.php/bdent/issue/view/46

MICRO-LEAKAGE OF PREHEATED COMPOSITE AS A CEMENTATION MATERIAL IN INDIRECT ADHESIVE RESTORATION (LITERATURE REVIEW)

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KEYWORDS

Microleakage, Preheated Composite, Preheated Cementation

ABSTRACT

Introduction: Composite resin is a material that is often used to perform dental restorations, but it can cause a deficiency called polymerization shrinkage which can be overcome by preheating the composite material. In several studies, there are differences of opinion regarding using preheating techniques at 60ºC to overcome polymerization shrinkage. **Review:** This article intends to analyze the level of microleakage on the restoration of adhesive indirectly as cementing materials with preheated composites. A total of 49 journals from PubMed, NCBI, BMC, Research gate, Z-library, EBSCO, Google Scholar, and other international journal websites were analyzed. **Conclusion:** The preheating method showed samples with heating of 60ºC had statistically lower microleakage at cervical margins. However, preheating resulted in an increase in the contraction voltage of undesirable polymerization.

INTRODUCTION

In the modern era, people think that appearance is a matter of concern in life, especially for those whose occupations demand looking good and attractive. Dental aesthetic appearance is one of the influential factors in social life because it can increase someone's self-confidence.[1] The effort to support the appearance and oral health can be done with dental restorations.[2]

Restorations are commonly used to restore the anatomical function and structure of missing teeth. Composite resin restorations consist of direct and indirect restorations.[3] Advances in polymer chemistry have contributed to the development of aesthetic restoration indirect attachment procedures in dental practice. The indirect method has several advantages instead of direct restoration.[4] The indirect restorations are currently attached using glass ionomer cement, resin-modified glass ionomer cement, and resin cement.[5] However, composite resins also have drawbacks resulting in microleakage and reduced edge adaptation called polymerization shrinkage.[6] The way to reduce the polymerization shrinkage problem is to use a preheating technique on the composite material.[6] The results of the study from Alvarado et. al stated that preheated resin is considered a cementing option for Class II indirect restorations on premolars and it is known that using preheated resin indirect restorations is better adapted.[7] In addition, Huzal concludes that the process of preheating or preheating significantly increases the bond strength of the composite inlay made using Gradia (for indirect restorations).[8]

Shrinkage of the composite resin results in the formation of micro leakages. Microleakage is a gap that occurs between the composite resin and the cavity wall so that bacteria, liquid, molecules, or ions can enter the filling.[9] Micro leaks can reduce the density of the edge of the restoration which will lead to hypersensitivity in restored teeth, tooth discoloration, secondary caries, and marginal stain, and can accelerate damage to the fillings themselves.[10]

Yang et al. stated that the use of composite materials as cementation materials with a preheating technique at a temperature of 60°C causes a large amount of micro-leakage.[11] In contrast, Didron et al. stated that the use of composites as cementation materials by preheating at 60°C led to a significant reduction in micro-leakage at the cervical margin.[12]

According to several studies, there is still a controversy that preheating of the composite resin technique can eliminate the leakage rate of the micro composite during cementation. Based on that, the author wants to review more about micro-leakage that is affected by preheating.

REVIEW

Indirect Restoration Adhesive

Indirect restoration has a good level of control on form and function, especially in situations of severe network loss.[2] Indirect restoration adhesive cementation is done by the way of an adhesive in the cavity, in the form of partial crown restorations made in composites or ceramics full and settles in the cavity passively. The adhesion process occurs because of the interlocking mechanism between the two types of materials and chemical bonds through silanization.[13] Indication for an adhesively cemented restoration is class II cavities covering the cusps (one or more) and restorations on the occlusal surface disturbed by the worn-out and/or biocorrosion.[14]

Cementation

Cement in dentistry is a mixture of powder and liquid which is a chemical reaction between an acid and a base. Powder that is alkaline and liquid that is acidic will form consistency in the form of a thick paste which will then harden and become a solid mass.[5] Dental types of cement have several functions, one of them serves as a luting agent to fill the gap between restorations made outside the mouth and teeth that were prepared by the way of a second streamed material and then solidify. So that it can be closed completely so that the liquid in the oral cavity and the invasion of germs does not enter the gap.[16.17]

Restoration Requiring Cementation Process

a. Gold Alloys of Precious Metals Restoration

Precious metals are metallic elements that are resistant to oxidation and corrosion in the humid air. Precious metals are not easily damaged by acids. The precious metals consist of gold, platinum, rhodium, ruthenium, iridium and osmium, silver, and palladium. The advantage of this metal is that it is resistant to chewing pressure, a tiny technique sensitive among all restorative materials, in clinical applications it is quite widely used, especially in posterior teeth.[19]

b. Metal-Based Mixture Restoration

Metals that are commonly used are metal-based Ni-Cr and Co-Cr. Mini metals were introduced to dentistry as an alternative to precious metals after a significant increase in gold prices. The advantages of this metal are low price, high level of hardness, resistance against discoloration and corrosion, low elasticity, low thermal conductivity, and low density.[20]

c. Ceramics Restoration

Dental ceramics are defined as non-metallic inorganic structures that generally consist of oxygen with one or more metallic or semi-metallic elements such as aluminum, calcium, lithium, magnesium, phosphorus, potassium, silicon, sodium, and zirconium, titanium.[20] Ceramic is a material widely used for physical and optical properties with a great capacity to meet the aesthetic and functional requirements.[21]

d. Metal Ceramic Restoration

In general, ceramic restoration is a combination of metal strength with the aesthetics of porcelain. The most common mechanical failure of metal-ceramic restorations is the de-bonding of porcelain from metal.[22] Metal ceramic crowns have the advantage that they are biocompatible, has good aesthetic value, has a large chewing load, but when the metal-ceramic GTC is attached, the oral cavity is often seen. Black shadows are reflected by metal coping, so the color of the resulting GTC does not match the natural color of the teeth next to it.[23]

Preheating Technique

Preheating technique is a heating technique that is carried out on composite resin materials, this technique is used before polymerization of the material to be applied into the cavity. Preheating technique aims to reduce the high viscosity of the composite material which has an impact on marginal edge adaptation, good hardness in micro composites, and can reduce microleakage due to shrinkage.[24] The composite resin heating device that is often used is The Calset™.[25]

Micro-leakage

Micro-leakage is the most important property that has been used in assessing the success of any restorative material used for restoration.[26] Edge leakage is used to indicate the ability of a material to form a material to create an effective barrier against fluids and bacteria present on the cavity surface and restorative material.[27]

Related Research on Microleakage Rates of Preheated Composites as Cementation Materials in the Indirect Adhesive Restoration

Several studies have been conducted regarding the microleakage rates of preheated composites in the use as cementation materials as follows: Yang et al. researched preheated composites with a temperature of 60°C showing the highest micro-leakage value, this contradicts the assumption that the higher the temperature, the better the marginal fit. This study determined the micro-leakage of the amount of color penetration along the teeth surface that had been treated with composite resin using a microscope.[11] Then a different study was conducted by Didron et al. The use of preheating technique on composites as cementation material with a temperature of 60°C led to a significant reduction in microleakage at the cervical margin.[12] This is contrary to the results which show that the greater the temperature, the greater the marginal fit.[12]

This study examines the microleakage rate of preheated composites in the use of cementation materials. Microleakage is an important indicator to determine the success of restorative material. Microleakage is defined as the entry of bacteria, fluids, molecules, and ions through the micro-gaps between the cavity wall and the restorative material where it cannot be seen clinically, this can cause tooth hypersensitivity, staining, secondary caries, pulp inflammation to pulp necrosis.[10,27,28] Indirectly prepared composite restoration is a good alternative to ensure that shrinkage is minimized.[7]

The result of the study from Alvarado et al. stated that preheated resin is considered a cementing option for class II indirect restorations in premolars. It is known that after using preheated resin the adaptation of the indirect restoration is better. This is because there is no significant difference in microfiltration in class II cavities using preheated resin or composite resin. Values obtained from microfiltration were lower for preheated resins than for composite resins, while micrographs obtained by electron microscopy revealed better adaptation to preheated resins. There is a study by Huzal which concludes that the preheated process significantly increases the bond strength of inlays made using Gradia composites (for indirect restorations). This is because, in the comparison between the experimental groups, the highest mean micro-tensile bond strength values were found in the GP group (the group where preheating was applied during restoration cementation, in the restoration group the restorations were restored using the Gradia posterior indirect composite material). Several factors can cause microleakage such as adaptation of the resin material to the tooth surface, the adhesive material used, and polymerization shrinkage of the material used.[29] In accordance with the opinion of Schmid-Schwan et al., which stated that the factors involved in the formation of marginal gaps and leakage in cavities and restorations are operator error, temperature variations, and inadequate humidity control for water absorption, polymerization shrinkage, and masticatory strength.[30]

A study conducted by Kampanas N states that preheated composite resins resemble flowable composites in achieving better adaptability by reducing viscosity, without losing their mechanical properties. Ideally, a preheated composite with a high flow rate could improve the adaptability of the resin to the cavity or tooth wall, and reduce the occurrence of micro leakages. This study showed the advantage of increasing the flow value of the composite resin by increasing its temperature. The advantages of preheated composites are the ease of application and increased marginal adaptation value, increased degree of monomer conversion, and better mechanical properties. The preheating method on the composite before polymerization showed that the marginal adaptation value was not affected by the flexural strength, and the viscosity increased.[24] Based on the results of Lopes L et al. research, it is stated that the preheating process for restorative materials had relatively successful results in increasing micro-hardness and conversion rates, reducing viscosity, and having better adaptation to cavity walls.[31]

Studies were conducted by Torres et.al at temperatures of 24°C, 37°C, and 68°C for silorane-based flitch composites and micro-hybrid composites. Preheated silorane increased the micro-hardness and modulus of elasticity of the composite but did not affect the flexural strength. In addition, the Z250 composite shows higher micro-hardness and flexural strength than silorane, but the modulus of elasticity is similar to the preheated.[32] This is different from the study conducted by Deb et al. which showed that an increase in the expected value of marginal adaptation and flow can have an effect on reducing microleakage, but the results showed that there is no significant difference between preheated composites (60°C) and composites without preheated (22°C).[33] This is in line with the research conducted by Soliman et al. It is known that there was no significant difference in microleakage scores between preheated composites and composites stored at room temperature.[25] However, another view of Dos Santos et al. finds that the decrease in microleakage in class II cavity restorations with preheated composites occurred when QTH was used with low radiation but did not increase when using high-radiation LEDs. It is also said that the group heated to 54°C gives better values than the room temperature group.[34]

Karaarslan et al. examined microleakage affected by preheating composites and found no significant difference between groups heated at different temperatures. It is also revealed that fewer micro leakages were observed at the occlusal margins than at the cervical margins. None of the restorations showed microleakage of enamel restorations or dentinal restorations along the cavity walls or axial walls at the occlusal margins.[35]

Yang et al. stated that preheated composites with a temperature of 50°C showed optimal restoration results with little or no microleakage compared to preheated composites with a temperature of 60°C and the control group (room temperature or without heating). With preheated composite, there is the ease of manipulation of the composite as it can be easily injected into the cavity without the use of hand instruments. However, it is recommended to work faster when using preheated composites to prevent temperature drop.[11]

Dissimilar to the study conducted by Didron et al., it is said that no significant differences were observed between materials and temperatures at the occlusal margins. In contrast, for all tested materials, samples heated to 60°C showed statistically lower microleakage at the cervical margin. The preheated composite at 60°C significantly reduced the cervical leakage rate in all tested materials and no microleakage was observed at the cervical margins in this group. Better adaptation of the composite to the cavity wall occurs because the viscosity of the composite decreases when being heated. The preheated technique results in an undesired increase in the polymerization contraction stress. It is needed further research on the consequences of increased pressure at the restoration interface on the strength of the restored tooth.[12]

According to the study by Elbahwy et. al. preheated composites can reduce the viscosity of Nanohybrid composites and can increase the adaptation of composites to cavity preparation walls, but there is no significant difference in microleakage values between preheated composites and Nanohybrid composites without heating or room temperature. This is attributed to the shrinkage due to thermal changes that occur when the composite is polymerized late at high temperatures. High temperatures can cause the material to return to its former form quicker. This happens because of the viscosity properties of the composite which will pull the composite from the tooth preparation wall.[36]

Studies by Zacattini et al. who evaluated the value of microleakage in mesio-occluso-distal Class II composite restorations suggested the use of preheated composite as a coating material if the cavity margin is below the CEJ to reduce the incidence of microleakage. In this study, it is found that the best reduction in the value of microleakage occurred in preheated composites compared to flowable composites.[37] There are several studies related to the title of the preheated composite microleakage rate as cementation material in indirect adhesive restorations. The following is a table presenting the results of a literature study on the effect of preheating on microleakage in the following table.

Table 1. Results of literature studies

Author, Year	Result
Torres *et al.* (2011)	Preheating silorane increases the micro-hardness and modulus of elasticity of the composite, but does not affect the flexural strength. However, preheating Z250 increases its microhardness, but does not change its flexural strength or modulus of elasticity.

Deb *et al.* (2011)	Adaptation in the preheating composites studied about enhanced flow which is useful for reducing microleakage with the results showing no significant difference.
Dos Santos (2011)	Preheated composite does not increase the microleakage by using high radiation LED. However, it was possible to reduce microleakage with QTH using low radiation.
Karaarslan *et al.* (2012)	There was no significant difference between the heated groups.
Yang *et al.* (2016)	Restorations heated to 50°C have good optimal results with little or no leakage compared to a composite micro preheated to the temperature of 60^0C and the control group (room temperature, without heating).
Soliman *et al.* (2016)	There was no significant difference in microleakage scores between preheated composites and composites stored at room temperature.

CONCLUSION

Based on research, heating the composite at a temperature of 50°C can reduce microleakage. The preheating method showed samples with heating of 60oC had statistically lower micro leaks at cervical margins. However, preheated resulted in an increase in the contraction voltage of undesirable polymerization.

Various results of this study still show many differences due to differences in the 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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