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Research Article

The Difference of Microleakage Between One-Bulkfill Resin Composite and Conventional Resin Composite

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Abstract

Resin composites are the most commonly used restorative materials and are constantly evolving due to their shortcomings which can affect the restoration results in polymerization shrinkage, leading to the formation of microleakage. Although incremental techniques have been found, this technique has drawbacks regarding the time required and the possibility of contamination. The invention of bulk fill resin composite can solve this problem. Manufacturers of One-Bulkfill (3M ESPE) claim that this material has less polymerization shrinkage than conventional resin composites, which is expected to have less chance of microleakage. This study aims to determine the difference in microleakage between one-bulkfill resin composites and conventional resin composites. 20 extracted premolars without caries and anomalies were utilized as research samples. These teeth were then prepared to form a class 1 cavity, then divided into two groups, namely; (1) One-Bulkfill (3M ESPE) and (2) Z350 XT (3M ESPE). These two samples were immersed in 1% Methylene Blue solution and observed using a Camera with a Macro Lens. Data were analyzed using an independent sample t-test. The results demonstrated a significant difference in microleakage between the two groups ($p = 0.014$, $p<0.05$). The mean value of microleakage in One-Bukfill composite resin restorations was 0.022, while Z350 XT composite resin restorations had 0.038. It can be concluded that the One-Bulkfill composite resin restoration had a smaller microleakage value than the conventional composite resin restoration (Z350 XT).

Keywords: bulkfill; composite resin; microleakage; polymerisation; shrinkage

INTRODUCTION

Composite resin restoration has become an important part of dental adhesives and bonding development.[1] In choosing a composite resin material suitable for modern treatments, consideration in the functional and mechanical properties is needed to create a durable restoration.[2] Interfacial surface sealing and the absence of microleakage edges are important factors that can affect the clinical outcome of restorations.[3]

Peutzfeldt Anne argues that microleakage can be caused by polymerization shrinkage.[4] Shrinkage in the composite resin is caused by densification during polymerization.[5] Composite resin shrinkage is a weakness that causes the formation of interfacial gaps, resulting in the formation of microleakage. Various techniques have been found to reduce this shrinkage. Some of these methods are incremental techniques to reduce the C-Factor. Furthermore, Softcure or Pulse delay cure techniques can slow down polymerization using intermediate materials, such as flowable composites, to reduce shrinkage at the edge of the cavity. However, using these techniques has disadvantages, namely, the possibility of

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contamination, long processing time, and difficulty of application due to limited access.[1]

Since the introduction of composite resins, much research and development of composite resin formulations have been carried out.[6] Experiments to change the formulation of composite resin materials over the years have focused on the initiator and filler mechanism. However, further research is needed to identify composite resin monomers.[4] Research on the formulation of resin components has shown that changes in the organic matrix of the composite resin contribute to shrinkage during polymerization.[7]

One of the current debatable issues in developing composite resin materials is bulk-fill composite resin. These composite resins can facilitate the application to deep cavities and speed up restoration procedures.[8] Although bulkfill can be a solution in facilitating the application of materials, the amount of shrinkage in bulkfill composite resins remains debatable.

Bulkfill composite resins have a shrinkage that is almost the same or even lower than conventional composite resins in wider cavities.[9] The shrinkage of bulkfill composite resins is not much different from conventional composite resins.[10] One of the results of this bulkfill composite resin development is the One-Bulkfill (3M ESPE) composite resin product. This bulkfill composite resin is expected to have a smaller shrinkage than other resins with a combination of AUDMA, DDDMA, and AFM monomers. Based on this background, this study aims to determine the difference between microleakage in One-Bulkfill restorative materials and conventional composite resins.

MATERIALS AND METHODS

This study is an experimental in vivo laboratory research conducted at the Integrated Skills Lab of Dentistry, University of Muhammadiyah Yogyakarta (UMY), and the Laboratory of Molecular Medicine and Therapy (MMT) UMY. Extracted premolars were utilized as the research samples. The premolars included caries-free teeth without anomalies in the structure. The samples were divided into two groups and filled using two different composite resin materials; 1) One-Bullkfill composite resin group and 2) Conventional composite resin group (Z350 XT).

Both groups were prepared prior to filling, forming a class 1 cavity. The occlusal portions of the teeth were leveled using a Flat disk bur. A depth of 2 mm was then created with a round bur and checked again with the WHO probe. It was trimmed to form a class 1 cavity in the form of a 4x4 mm cube.

After the cavity was well formed, it was then filled. This study utilized a two-step total-etch system: etching and bonding Generation 5 and Single Bond Universal Adhesive (3M ESPE). The etching process was performed for 15 seconds, then rinsed with water until clean and dried with dampness using a cotton swab. The bonding process was carried out and aerated gently for 10 seconds. It was then cured using Light Cure (LB 200) for 20 seconds.

The filled teeth were then immersed in artificial saliva at 37ºC in an incubator for 24 hours. The tooth was coated with a water-repellent varnish (nail polish) on the tooth surface and the area around the marginal restoration. The apical foramen was closed using a bond, which was then light-cured. The tooth was coated with red wax on half the length of the teeth. It was immersed in a 1% methylene blue solution for 24 hours to lead the solution to infiltrate into the micro-gaps in the filling. The tooth was then split using a double-sided diamond disc bur in the mid-sagittal transversely so that the filling and cavity boundaries could be observed. The observation was carried out using photos taken by Nikon D 5200 and 18-200mm af-s VR (reversed) with a macro adapter lens then the microleakage was enlarged. The photos were processed using Image J software to measure the area of the microleakage formed. The surface area where the microleakage was formed, such as the area of a rectangle and a triangle, was visible and colored with methylene blue. The data obtained from observation was the area of microleakage for each sample. Furthermore, the normality test was carried out using the Shapiro-Wilk test method and a comparative independent sample t-test.

RESULT

The results of observing the extent of microleakage in all samples can be seen in table 1.

Table 1. Average Value and Standard Deviation of Microleakage Area

Sample	One-Bulkfill Mm^2	Z350 XT Mm^2
1	0.0283130	0.0412980
2	0.0117380	0.0190080
3	0.0217480	0.0385880
4	0.0275400	0.0386300
5	0.0164450	0.0195830
6	0.0139680	0.0610080
7	0.0331700	0.0364580
8	0.0247250	0.0511500
Average	0.022205875	0.038215
Standard Deviation	0.007588941	0.014221707

Table 1 shows the difference in the mean number of microleakage areas in the two groups. The two groups were tested statistically using the independent sample t-test and are displayed in table 2. As shown in the image below, Figure 1 shows a microleakage from One-Bulkfill, while Figure 2 shows a microleakage from Z350XT.

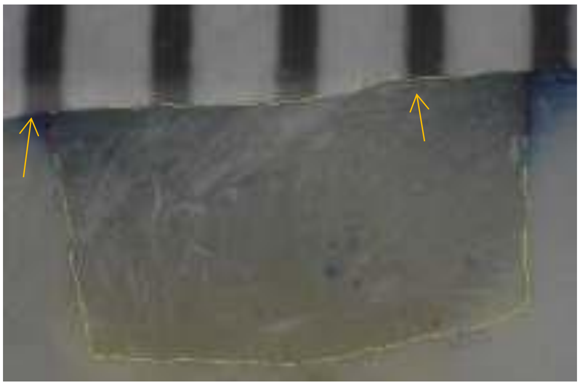

Figure 1. One-Bulkfill Microleakage Observation

Figure 2. Z350XT Microleakage Observation

Table 2. Average Value and Standard Deviation of Microleakage Area

t-test for Equality of Means	T	df	Sig. (2-tailed)
Measurement Value	-2.809	14	.014

Table 2 shows the significance of p=0.014 ($p<0.05$) on the difference in microleakage area between the One-Bulkfill group and the Z350 XT treatment. The results revealed a significant difference in microleakage between the two groups ($p = 0.014$, $p<0.05$). The mean value of microleakage in One-Bukfill composite resin restorations was 0.022, while the mean value in Z350XT composite resin restorations was 0.038. It indicated that One-Bulkfill composite resin had a smaller microleakage value than conventional composite resin restorations (Z350 XT).

DISCUSSION

The independent sample t-test demonstrated that the One-Bulkfill composite resin restoration and the Z350 XT composite resin had microleakage due to the nature of the composite resin, which was easy to shrink.[11] there is no composite resin material can adapt perfectly to a cavity.[1] Furthermore, the results of statistical tests in this study showed a statistically significant difference between the microleakage of One-Bulkfill composite resin restorations and Z350 XT composite resin restorations. The Z350 XT group (0.038) scored higher than the One-Bulkfill group (0.002). The amount of polymerization shrinkage and shrinkage-induced stress can be influenced by four things; (1) the total volume of the composite material, (2) the type of composite, (3) the polymerization speed, and (4) the C-Factor.[12]

The type of composite in this study had different characteristics in terms of bulk fill and conventional composite resins. Bulk fill composite resins have been manufactured to be applied to 4 mm thickness or more, while conventional composite resins generally can only be applied to 2 mm thickness.[13] The material volume and C-factor will affect polymerization shrinkage and shrinkage-induced stress.[12] Bulkfill composite resin types should have a lower level of microleakage and polymerization shrinkage as they are designed to be applied to larger and deeper cavity sizes than conventional composite resins.[13]

The difference between the two types of composite resin is also revealed in the resin matrix monomer used. One-Bulkfill composite resin adds AUDMA, DDDMA, and AFM. AUDMA monomer is known to have a high molecular weight.[14] It can help reduce polymerization shrinkage by reducing the polymer bonds.[12] In addition to AUDMA, One-Bulkfill composite resin also adds DDDMA monomer, which has a fairly high modulus of elasticity.[14] The modulus of elasticity can be considered a factor that greatly affects shrinkage-induced stress, leading to the formation of microleakage.[15,16] AFM monomers in One-Bulkfill composite resins also significantly reduce shrinkage-induced stress with the CANs mechanism. It can create polymer bonds with other monomers and provide a relaxation effect by breaking the third reactive group and adapting to form new polymer bonds.[16,17] The combination of these monomers can reduce polymerization shrinkage and shrinkage-induced stress, which causes microleakage in the composite resins.[18,19,20]

CONCLUSION

The discussion concludes that the value of microleakage in the One-Bulkfill and Z350 XT groups was significantly different. Higher leakage values were revealed in the conventional composite resin group (Z350 XT).

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