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# Effect of the thickness of flowable composite as intermediate layer to reduce microleakage on gingival wall

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**Abstract.** Microleakage of composite restoration in proximal composite restoration often occurs on the gingival wall. The purpose of this study is to evaluate the influence of flowable composite as an intermediate layer to reduce microleakage on the gingival wall. Thirty whole,extracted, upper premolars were divided into three groups. Within box-like cavities, the first group was restored with packable composite only. Group 2 was restored with flowable composite of a1mm thickness and then was restored with incrementally packable composite. Group 3 was restored similarly to group 2, however with a flowable composite thickness of 2mm. After thermocycling, the penetration of 1% methylene blue was investigated along the gingival wall. There were significant differences between group 1 and groups 2 and 3. No significant differences were found between groups 2 and 3. Flowable composite, as an intermediate layer, reduces microleakage of the gingival wall of proximal composite restorations. Nonetheless, the thickness of the flowable composite has no influence on the amount of microleakage observed.

## 1. Introduction

Composite resin has been widely accepted as a restorative material in the proximal cavity of posterior teeth, replacing amalgam. Composite resin has an enhanced material properties and adhesive system [1,2]. However, until now, the nature of contraction due to the polymerization reaction of composite resin is still a major challenge in the use of this material [3,4]. The polymerization contraction causes an increase in concentrated pressure on the surfaces binding to the dental tissue, causing the adaptation of the edges of the restoration to become unfavorable [3,5,6]. There are several techniques for reducing polymerization contraction problems including incremental placement techniques, as well as the application of composite resin layers between the cavity surface and the plastic composite resin [3,7]. The material used in these techniques includes materials that have a dentine-like, elastic modulus, such as glass ionomer cement or flowable composite resins [8,9].

The use of flowable composite resin as an intermediate layer in overcoming the stress of the contraction of the packable composite resin layer over it is still controversial because the volume level of the contraction is still quite high [4, 9-11]. Therefore, material technology has developed a flowable composite as dentin substitute (such as SDRTM, Dentsply), which aims to reduce the volume level of contraction of flowable composite materials by modifying the pre-polymerized 4-trimethylhexane, urethane dimethacrylate (UDMA) monomer, as well as the amount filler content of 68% weight per volume [12]. According to Roggendorf (2011), SDRTM can even be placed in bulkfil as thick as 4 mm [13]. However, the effectiveness of flowable composites as intermediate layers and their optimal thickness in reducing gingival wall leakage in the proximal cavity requires further research. This study aims to analyze the effects of use and thickness of a dentine-based composite in a proximal composite resin spill for gingival wall leakage.

## 2. Materials and Methods

This study was a laboratory experimental study, and a sample of 30 maxillary, premolar teeth were extracted for orthodontic use. These teeth were caries free, had intact tooth crowns, and had fairly wide occlusal surfaces. After the teeth were soaked in a saline solution for one week, cavity preparation was performed on the mesial side of each tooth with a 4 mm wide bucco-palatal size and 2mm gingival wall width, with a depth of 5mm; at this depth, it was expected that there would be a healthy remnant of the enamel. The accuracy of the cavity measurements was aided by the use of periodontal probes and magnification by 2.5 times. The cavity surface angle was not beveled. The specimens were divided into three groups, each consisting of ten samples. Metal band matrix was mounted on the teeth with universal matrix. Following the self-adhesion application procedure, each sample was categorized according to its group. In the first group, the tooth was restored with packable composite alone, by 2 mm increments (the control group). In the second group, the tooth was restored with a 1mm dentin compression flowable (SDRTM, Dentsply) compression application with a ball-pointed instrument on a cavity basis after it had been restored with an incremental, packable composite resin. The third group was restored similarly to the second group, but the dentin composite, flowable application (SDRTM, Dentsply) was 2 mm thick. The final solution and polishing were completed with OptiDiscTM.

All specimens were stored in containers of saline solution at 37ºC in incubator degrees for 24 hours. The extent of the thermal cycling procedure was performed manually as much as 250 times, in a temperature range of 5–55 ºC, with a soaking time and rest of 30 and 15 seconds, respectively. The entire apex sections of the specimens were cut 2 mm from the apex and were subjected to a glass of ionomer cement. The entire surface of the tooth was then treated with nail varnish, up to a limit of 1 mm from the edge of the restoration. The specimens were then immersed in 1% methylene blue for 24 hours at 37ºC in the incubator. The cutting of the specimens was done in a bucco-lingual direction with a low-speed diamond disk. Penetration of the 1% methylene blue substance was measured with a stereo magnification microscope, which was equipped with a digital camera and magnified by 25 times. The score leakage scale, as proposed by Korkmaz *et al.*, was as follows: 0 = no penetration occurs, 1 = penetration of up to 1/3 of the gingival width, 2 = penetration of more than 1/3–2/3 the width of the gingiva, and 3 = penetration reached 2/3–edge of the axial wall [14].

## 3. Results and Discussion

### *3.1 Results*

The results of the distribution of the microleakage scores of the samples are displayed in Table 1 below. Score 0 was the highest for group 1 (30%), followed by group 2 (23.3%), and the control group (0%). Microleakage in the gingival wall was the highest in the control group and the least prominent in

**Table 1.** Distribution scores of microleakage gingival walls in proximal cavity

| Group | Microleakage Scale | | | | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | | 1 | | 2 | | 3 | | |
| | N | % | n | % | N | % | N | % | |
| Control | 0 | 0 | 2 | 6.7 | 0 | 0 | 8 | 26.7 | 10 |
| SDR1 | 9 | 30 | 1 | 3.3 | 0 | 0 | 0 | 0 | 10 |
| SDR2 | 6 | 20 | 2 | 6.7 | 0 | 0 | 2 | 6.7 | 10 |
| Total | 15 | 50 | 5 | 16.7 | 0 | 0 | 10 | 33.7 | 30 |

SDR1 = composite resin restoration with SDR as a liner
SDR2 = composite resin restoration with SDR as a basis

group 1, followed by group 2. From Table 2, the value of micro-leakage on the gingival walls of the control group was significantly different between the SDR1 and SDR2 groups, but no significant differences were found between the SDR1 and SDR2 groups. An example of the leakage scores is illustrated in Figure 1 below.

**Table 2.** Significant difference of microleakage of gingival walls in proximal cavity between the test groups

| Group | p-value |
|---|---|
| Control vs SDR1 | 0.010* |
| Control vs SDR2 | 0.015* |
| SDR1 vs SDR2 | 0.988 |

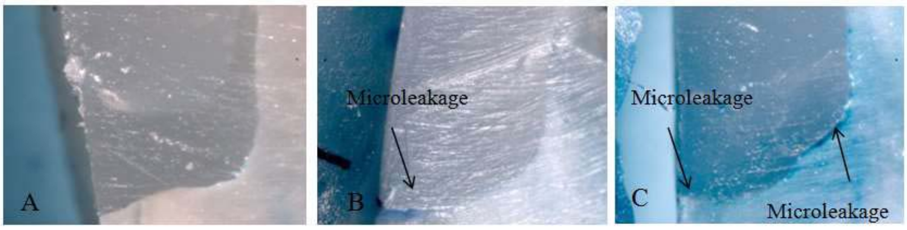


**Figure 1**. Microleakage of gingival walls with score 0 (A), score 1 (B), and score 3 (C)

*3.2 Discussion*

This research is an in vitro study using the dye penetration method, which was introduced by Roulet *et al*. (1981). In this type of study, researchers should aim for uniformity within the tooth samples so that the anatomical variations of each sample are minimal. The teeth were immersed in saline water and placed in an incubator to retain moisture, affecting dentine hardness and simulating oral conditions [15]. The adhesive system used was the self-etch technique, which has a short application time. In this system, the infiltration process of the resin monomer occurs simultaneously with the self-etch process so that the risk of error occurring between the two processes is minimized. Several previous studies have shown microleakage of dentine in the use of this technique, exhibiting results that are as good as the etch-rinse system [14]. The flowable composite resin material used as the dentin substitute for the intermediate layer in this research was the composite resin, flowable SDRTM (Dentsply). This material is a newly introduced as dentin substitute, which is able to be placed up to 4mm thick at a time, followed by a conventional composite resin layer of 2mm thick on top of it [16,17].

The samples were subjected to thermal cycling treatment to simulate the restoration situation in the oral cavity undergoing continuous thermal changes [18]. The thermal cycle performed a total of 250 revolutions at a temperature of 5–55 ºC and with a rest period of 15 seconds. The number of cycles, 500 rounds, which is half of the standard International Organization for Standardization (ISO) TRI11450, were done manually [19]. According to Wahab F.K. *et al*. (2003) only a small number of rounds alone can cause microleakage in composite resin restorations [15,18,20,21]. In comparison to other leak detector dyes (such as India ink, basic fuchsin, and silver nitrate),1% methylene blue dye, due to its very small molecule size (0.059 nm), which is smaller than bacteria (0.5–1μm), can penetrate further [22]. However, in this study, the small size and the low molecular weight of the blue methylene ink molecules caused the ink to penetrate the pulp chamber.

Table 1 displays the leakage of the gingival walls in the different control groups with significant proximal cavities that were restored using a layer between the flowable composite resin of the dentine replacement. The flowable composite resin had a better flow power on the cavity edge than it did on the packaged composite resin, but it had a fairly high contraction volume [23,24]. Modifications to the flowable SDRTM composite resin were performed in order to improve the physical properties of the conventional flowable composite resin by adding the effective filler amount (68% by volume) to reduce the volume of the contraction of this flowable composite resin. The use of UDMA monomers with chemical structures that had undergone pre-polymerization, as modulators of greater molecular weight cause the polymerization contraction reaction to occur, was expected to cause minimal contraction, yet still display adequate flow power [13, 24-26]. As depicted in Table 2, the thickness of the dentine substitute composite resin application as an open intermediate layer (whether applied thinly as a liner or as a thick layer) showed no significant differing results in this study, which demonstrated no leakage at the edges of the proximal cavity gingival walls. This is due to the use of SDRTM as a flowable, composite resin dentine substitute, having an UDMA pre-polymerization monomer, which allowed this material to be placed in a thicker volume [27].

However, although they were not significantly different, the descriptive statistics on the dentin-treated, substitute composite resin group, which had a greater thickness, showed that some samples leaked on the gingival wall, in comparison to the group using a thinly-applied dentin substitute composite resin. The composite resin is flowable, even though it has a low volume contraction level of 3.7%; however, the total volume of the contraction remains considerable when it is compared to the packaged composite resin (1.3–3.22% of the total contraction volume) [21], so that the thicker the total composite volume, the greater the contractions maybe. There are several things to note regarding the use of flowable composite resin as an intermediate layer material that is open when it is placed too thick in the oral cavity. Poggio *et al*. revealed a significant increase in the surface roughness and wear of the dentine-treated composite resin, given erosive treatment by acidic fluid [28]. From the compression power angle, the flowable composite resin also retains a lower strength than the packable composite; as a result, it should not lie in the stress-bearing area [29]. The use of flowable composite resin as an open layer should be based on other aspects, rather than just the microleakage edge of the restoration [30].

## 4. Conclusion

The application of a dentine-substitute, flowable composite resin to the restoration of a proximal composite resin can reduce the rate of microleakage of the gingival wall. In this study, the thickness of the doped composite resin flowrate layer, which was between 1 mm and 2 mm, was not observed to affect the leakage level of the gingival wall.

## References

[1] Yahagi C, Takagaki T, Alireza S A D R, Ikeda M, Nikaido T and Tagami J 2012 Effect of lining with a flowable composite on internal adaptation of direct composite restorations using all in one adhesive system. *J. Dent. mater*. **31** 481-8.
[2] Tanno K, Hiraishi N, Otsuki M and Tagami M 2011 Evaluation of cavity adaptation of low-shrinkage composite resin *Asian Pac. J. Dent*. **11** 27-33.
[3] Karthick K, Kailasam S, Priya P G and Shankar S 2011 Polymerization Shrinkage of Composites -A Review *JIADS*. **2** 32-6.
[4] Lindberg A, Dijken J W V V and Hörstedt P 2005 In vivo interfacial adaptation of class II resin composite restorations with and without a flowable resin composite liner. *J. Clin. Oral Invest.* **9** 77-83.
[5] Cadenaro M, Marchesi G, Antoniolli F, Davidson C, Dorigo E D S, and Breschi L 2009 Flowability of composites is no guarantee for contraction stress reduction. *J. Dent. Mater*. **25** 649-54.
[6] Russo A B and Swift E 2007 Class II composite resin restoration with gingival margin in dentin. *J. Esthetic Restor. Dent*. **19** 171-7.
[7] Tredwin C, Stokes A and Moles D 2005 Influence of flowable liner and Margin location on microleakage of conventional and packable class II resin composites *J. Oper. Dent*. **30** 32-8.
[8] Arora R, Kapur R, Sibal N and Juneja S 2012 Evaluation of microleakage in Class II cavities using packable composite restoration with and without use of liners. *IJCPD*. **5** 178-84.

[9] Ziskind D, Adell I, Teperovich E and Peretz B 2005 The effect of an intermediate layer of flowable composite resin on microleakage in packable composite restorations. *Int. J. Paediatric Dent.* **15** 349-54.
[10] Jain P and Belcher M 2000 Microleakage of class II resin-based composite restorations with flowable composite in the proximal box. *JADA*. **13** 235-8.
[11] Swift E, Triolo P, Barkmeier J, Bird J and Bounds S 1996 Effect of low-viscosity resins on the performance of dental adhesives. *JADA*. **9** 100-4.
[12] Arslan S, Demirbuga S, Ustun Y, Dincer A N, Canakci B C and Zorba Y O 2013 The effect of a new-generation flowable composite resin on microleakage in Class V composite restorations as an antarae layer. *J. Conserv. Dent.* **16** 189-93.
[13] Roggendorf M J, Kramer N, Appelt A, Naumann M and Frankenberger R 2011 Marginal quality of flowable 4-mm base vs. conventionally layered resin composite. *J. Dentistry*. **39** 643-7.
[14] Ozel E, Korkmaz Y, Attar N 2006 Influence of location of the gingiva margin on the microleakage and internal voids of nanocomposites. *J. Contemp. Dent. Practice*. **9** 1-10.
[15] Purk J H, Dusevich V, Glaros A, Spencer P and Eick D 2004 In vivo versus in vitro microtensile bond strength of axial versus gingiva cavity preparation walls in Class II resin-based composite restorations. *JADA*. **135**185-93.
[16] Arslan S, Demirbuga S, Ustun Y, Dincer A N, Canakci B C and Zorba Y O 2013 The effect of a new-generation flowable composite resin on microleakage in Class V composite restorations as an intermediate layer. *J. Conserv. Dent*. **16** 189-93.
[17] Ilie N and Hickel R 2011 Investigations on a methacrylate-based flowable composite based on the SDR technology. *J. Dent. Mater*. **27** 348-55.
[18] Nalcaci A and Ulusoy N 2010 Effect of thermocycling on microleakage of resin composit polymerized with LED curing techniques. *J. Quitessence Int*. **37** 33-9.
[19] Tonetto M R, Bandeca M C, Barud H Gd O, Pinto S C S, Lima D M, Borges A H, *et al*. 2013 Influence of artificial aging in marginal adaptation of mixed class v cavities. *JCDP*.**14** 316-9.
[20] Wahab F K and Shaini F J 2003 Evaluation of the microleakage at the proximal walls of Class II cavities restored using resin composite and procured composite inserts. *J. Restorative Dent*. **34** 1-5.
[21] Wahab F K, Shaini F J and Morgano S M 2003 The effect of thermocycling on microleakage of several commercially available composite Class V restorations in vitro. *J. Prosthodontic Dent*. **9** 169-73.
[22] Ahlberg K, Assavanop and Tay W 1995 A Comparison of the apical dye penetration patterns shown by methylene blue and india ink in root-filled teeth. *Int. Endod. J*. **28** 30-4.
[23] Xavier JvC, Monteiro G Q and Montes M A 2010 Polymerization shrinkage and flexural modulus of flowable dental composites. **13** 381-4.
[24] Ikeda I, Otsuki M, Alireza S A D R, Nomura T, Kishikaya R and Tagami J 2009 Effect of filler content of flowable composites on resin-cavity interface. *Dent. Mater. J*. **28** 679-85.
[25] Trey D 2011 Scientific Compendium Dentsply Smart Dentin Replacement *Surefil SDR Flow* (USA: Dentsply).
[26] Chuang S, Jin Y, Liu J, Chang C and Shieh D 2004 Influence of Flowable Composite Lining Thickness on Class II Composite Restorations. *J. Oper. Dent*. **29** 301-8.
[27] Zaruba M, Wegehaupt F J and Attin T 2012 Comparison between Different flow application Techniques: SDR vs flowable composite. *J. Adhes. Dent*. **15** 115-21.
[28] Poggio C, Dagna A, Chiesa M, Colombo M and Scribante A 2012 Surface roughness of flowable resin composites eroded by acidic and alcoholic drinks. *J. Conservative Dent*. **15** 137-40.
[29] Purk J H, Healy M, Dusevich V, Glaros A and Eick D J 2006 In Vitro microtensile bond strength of four adhesive tested at the gingival and pulpal walls of class II restorations. *J. Am. Dent. Assoc*. **137** 1414-8.

[30] Salerno M, Derchi G, Thorat S, Ceseracciu L, Ruffilli R and Barone A 2011 Surface morphology and mechanical properties of new-generation flowable resin composites for dental restoration. *J. Dent. Mater*. **27** 1221-8.