

Original Research

A Comparative Evaluation of Marginal Adaptation of Different Bulk fill Composites Using Stereomicroscopy: An In Vitro Study

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ABSTRACT

Objectives :

To determine the marginal adaptation of 3 different bulk fill and one conventional composite in class 2 cavities

Methods :

Sample size being 40 extracted teeth, two standard class 2 cavities were prepared in each tooth. Teeth were randomly assigned to one of the four experimental groups (n=10; cavities=20). The experimental groups were Group 1 – SonicFill ; Group 2 – SDR ; Group 3 – FillUp ; Group -4 Filtek Z-350. After the finishing procedure, teeth were hydrated and immersed in silver nitrate and photo developing solution. All samples were sectioned horizontally and subjected to 30X stereomicroscopy to check the amount of microleakage.

Results :

All four groups showed significant difference in microleakage, however Sonic Fill and SDR showed good marginal adaptation.

Conclusion :

In class 2 cavities, bulk fill composites showed better marginal adaptation than traditional composite using incremental technique.

INTRODUCTION

Composites restorations has a long history since 1970's. Almost half of all direct restorations of class 2 cavities are restored using composites¹

Tooth restored with resin based composites faces many problems, most common among them is patient complaining of post operative sensitivity after restoration.^{3,4} This is mainly due to gap formation at the resin tooth interface.^{3,9}

In uncured resin, van der Waals forces act by

loosely holding the monomer components at a spacing that generates the lowest potential energy.¹¹ For this reason, in the pre-gel phase, the stresses which are generated are effectively reduced by flexure and flow of the material. As a polymer, the lowest potential energy spacing is 20% less than that in the unreacted monomer. In post-gelation phase, stresses which are generated are not reduced by material flow and are liable to develop at the tooth resin interface. During the pre-gel and post-gelation phase, the phenomenon of total

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volumetric shrinkage of resin based composites is referred to as 'polymerization shrinkage' and it is in the range of 2.9 to 7.1 vol%, which generates contraction stresses up to 7 MPa.¹¹

The phenomenon of marginal failure and subsequent microleakage are commonly seen in traditional (highly viscous) composites, to overcome this low viscous composites were introduced.

Low viscosity flowable resin composites contains lower percentage of inorganic filler particles and higher amount of resin components.² which causes minimum stress contraction.² But with low viscosity composites the main disadvantage is their lower mechanical properties,² so the quest for composite which combines the properties of low viscosity composites like good flow and better adaptation, along with high viscosity composite properties such as superior mechanical properties led to the introduction of the above mentioned bulk fill composites.

Bulk fill material was introduced in the market in 2011 and are now considered the state of art of restorative dentistry.¹⁰ An exquisite bulk fill composite would be the one that could be restored in the cavity preparation design with high 'C' factor and still demonstrating minimal polymerization shrinkage stress, while maintaining a high degree of cure throughout.¹² Despite all the above mentioned advantages of bulk fill there was a doubt that, compared to incremental packing, bulk filling may exhibit higher polymerization stresses that can compromise the marginal adaptation at the resin tooth interface.¹⁰

So in this study we incorporated 3 bulk fill composites Sonicfill, SDR and Fillup and compared its marginal integrity with conventional composite Filtek Z-350 using stereomicroscopy.

The null hypothesis of this study states that there is no difference in marginal adaptation of different bulk filled and conventional composites.

MATERIALS AND METHODOLOGY :

METHODOLOGY

COLLECTION OF TEETH:

INCLUSION CRITERIA:

Forty multirrooted intact human permanent molars which were extracted for orthodontic and periodontal reasons were included in this study. Informed written consent was obtained from the patients to use their extracted tooth for the study. Specimens were collected over a period of one month.

EXCLUSION CRITERIA:

- 1) Teeth with caries.
- 2) Teeth with cracks.
- 3) Teeth with restorations.
- 4) Teeth with fractured crown.
- 5) Teeth with proximal wear.
- 6) Hypo plastic teeth .

PROCEDURE:

Sample preparation:

A total of forty freshly extracted human multirrooted permanent maxillary and mandibular molars within the span of one month of extractions were used in this study. All the teeth samples were immersed in hydrogen peroxide solution and were cleaned from remaining connective tissues and debris using ultrasonic method and then stored in physiological saline till its use. Using straight fissured shaped diamond point in airtor two class II cavities were prepared on mesio-occlusal and disto-occlusal surfaces with a depth of 4 mm occluso-gingivally, width of 2 mm mesio-distally and length of 3 mm buccolingually. (Figure 1)

Sample size and groups:

The sample size was derived using GPower 3.0.10 software using data obtained from previous study done by M Orłowski. Effect size was calculated using values of mean and standard deviation from previous study.

Restorative procedures :

Forty teeth samples with class II cavities were randomly divided into four groups, each group having 10 samples and 20 cavities. All the samples were etched using 37% phosphoric acid and were rinsed using water spray then air dried to leave the dentin moist and shiny.

Dentin bonding agent was applied with an applicator tip, gently air dried and light cured for 20 seconds using LED light curing lamp spectrum 440nm, power 900 mw/cm² for all the samples.

Mylar strip was placed using tofflemire retainer around both the class II cavities and same composite was filled on both mesio-occlusal and disto-occlusal cavities in each tooth according to the groups assigned.

Group 1 (n=10): SonicFill (Kerr) using Sonic activated handpiece (KaVo).

Before dispensing the Sonicfill, the air pressure of the dental unit was adjusted to 50 PSI according to manufacturer's recommendation. The dispensing rate/speed was adjusted to setting 3. Sonicfill unidose tip was placed around one half millimeter above the gingival margin to avoid air entrapment. Using foot pedal Sonicfill handpiece was activated and material was dispensed in class II cavities. Dispensing tip was kept in the material until full depth of cavity is filled and by doing so the material is continuously liquefied during placement. Sculpting and carving was done with the composite placing instrument and the material was then cured for 20 seconds.

Group 2 (n=10): SDR (DENTSPLY) using Compula tip and dispensing gun (device).

SDR was placed using SDR dispensing gun. Compula was attached to this dispensing device and the tip was placed one half millimeter above the gingival margin and the flowable resin was placed by pressing the dispensing gun until full depth of cavity is filled and then light curing was done for 20 seconds

Group 3 (n=10): Fillup (Coltene) using Automix syringe and automixing tip

Fillup was dispensed through its automix syringe using automixing tip starting from the gingival margin and mixing tip was kept inside the material until full depth of cavity is filled and light curing was done for 10 seconds after waiting for 3 minutes for the material to set on its own.

Group 4 (n=10): Filtek Z350 (3M ESPE) using horizontal-oblique incremental technique

Filtek Z350 was placed using incremental technique in three increments, horizontal increment of 2mm followed by two consecutive oblique increments. The first increment was horizontally placed at the cervical wall and light cured for 20 seconds. The second increment was obliquely placed contacting the buccal axial walls and the previously cured increment, followed by light curing for 20 seconds. The third increment was obliquely placed, filling the preparation and light cured for 20 seconds.

All the samples were finished using Shofu burs and polishing was done using Soflex discs.

Microleakage Assessment:

All the tooth samples were dried and their occlusal surfaces were protected with pink wax and smooth surfaces of the teeth were coated with nail varnish leaving a margin of 1mm around the composite filling.

All the samples were then placed in physiological saline for 24 hours to hydrate the teeth desiccated tissues. The samples were then immersed in an aqueous solution of silver nitrate for 24 hours followed by photo developing solution for 8 hours.

All the restorations were analyzed using stereomicroscope at 30x magnification to assess dye penetration along the walls after

Original Research

Table - 1. Comparison of mean microleakage scores.

Groups	N	Mean micro-leakage score	Mean Rank	chi-square value	p value
SONIC FILL (KERR, KAVO)	10	0.20	15.90	14.904	0.002*
SDR (DENTSPLY)	10	0.10	14.20		
FILLUP (COLTENE)	10	0.60	21.70		
FILTEK Z-350 (3M ESPE)	10	1.50	30.20		

Kruskal-Wallis test; * indicates significant at $p \leq 0.05$

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Table – 2. Pairwise comparison between different groups

1.1.1. Pairs	1.1.2. Groups	1.1.3. Mean micro-leakage score	1.1.4. Mean Rank	1.1.5. z value	1.1.6. p value
1.1.7. Pair 1	1.1.8. SONIC FILL (KERR, KAVO)	1.1.9. 0.20	1.1.10. 11.00	1.1.11. - 0.610	1.1.12. 0.542
	1.1.13. SDR (DENTSPLY)	1.1.14. 0.10	1.1.15. 10.00		
1.1.16. Pair 2	1.1.17. SONIC FILL (KERR, KAVO)	1.1.18. 0.20	1.1.19. 8.90	1.1.20. - 1.446	1.1.21. 0.148
	1.1.22. FILLUP (COLTENE)	1.1.23. 0.60	1.1.24. 12.10		
1.1.25. Pair 3	1.1.26. SONIC FILL (KERR, KAVO)	1.1.27. 0.20	1.1.28. 7.00	1.1.29. - 2.858	1.1.30. 0.004*
	1.1.31. FILTEK Z-350 (3M ESPE)	1.1.32. 1.50	1.1.33. 14.00		
1.1.34. Pair 4	1.1.35. SDR (DENTSPLY)	1.1.36. 0.10	1.1.37. 8.45	1.1.38. - 1.933	1.1.39. 0.053
	1.1.40. FILLUP (COLTENE)	1.1.41. 0.60	1.1.42. 12.55		
1.1.43. Pair 5	1.1.44. SDR (DENTSPLY)	1.1.45. 0.10	1.1.46. 6.75	1.1.47. - 3.124	1.1.48. 0.002*
	1.1.49. FILTEK Z-350 (3M ESPE)	1.1.50. 1.50	1.1.51. 14.25		
1.1.52. Pair 6	1.1.53. FILLUP (COLTENE)	1.1.54. 0.60	1.1.55. 8.05	1.1.56. - 1.944	1.1.57. 0.052
	1.1.58. FILTEK Z-350 (3M ESPE)	1.1.59. 1.50	1.1.60. 12.95		

Mann-Whitney test; * indicates significant at $p \leq 0.05$

Graph 1 - Mean Micro-leakage score

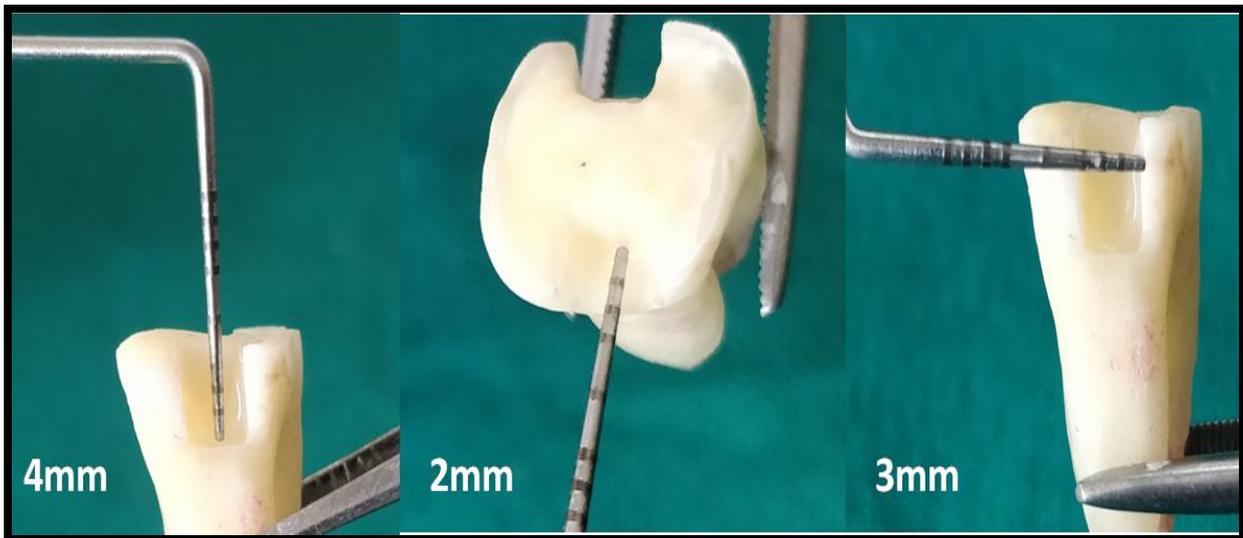
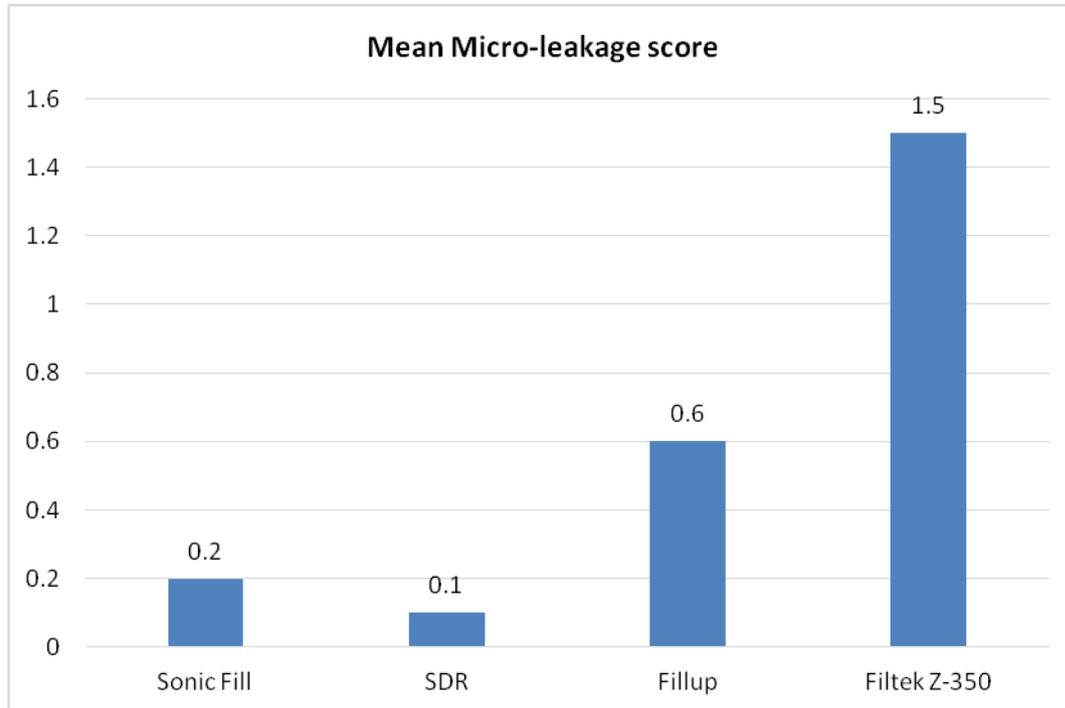


Figure 1 : Cavity Dimensions with Depth of 4 mm Occluso- Gingivally, Width of 2 mm Mesio-Distally and Length of 3 mm Bucco-Lingually



Figure 2: Restoring The Cavity Using A) Sonic Fill B) Sdr C) Fillup D) Filtek Z350



Figure 3 : Vertical Sectioning Of The Tooth Samples

subjecting to longitudinal sectioning (Figure 3) and at the centre to evaluate for dye penetration along the gingival wall.

Cut samples were examined under 30X stereomicroscope and scored according to criteria.⁴

0. = no microleakage.
1. = silver nitrate penetrates up to the dentino-enamel junction (DEJ) or correspondent length at the dentin wall.
2. = silver nitrate penetrates beyond the DEJ or correspondent length at the dentin wall, surpassing half the cavity depth.
3. = silver nitrate penetrates beyond half the cavity depth, without reaching the axial wall.
4. = silver nitrate penetrates along the axial walls.

Results :

Data was analyzed using Statistical Package for Social sciences version 16 (SPSS -16) statistical software.

Using Kruskal-Wallis test the mean score for micro-leakage was least for SDR group (0.10), followed by Sonicfill group (0.20) and Fillup group (0.60). Filtek Z-350 showed highest score for micro-leakage (1.50). This difference in micro-leakage among four groups was significant ($p=0.002$). (Table 1) (Graph 1)

Using Mann-Whitney test it shows that difference in micro-leakage between Sonic fill and SDR and between Sonic fill and Fillup was not significant ($p>0.05$). However difference in

micro-leakage between sonic fill and Filtek z-350 was significant ($p=0.004$). Similarly, difference in micro-leakage between SDR and Fillup was also non-significant ($p=0.053$); but difference in micro-leakage between SDR and Filtek z-350 was significant ($p=0.002$). Similarly, difference in micro-leakage between Filtek z-350 and Fillup was also non-significant ($p=0.052$). (Table 2)

Discussion :

In our study we selected 3 different types of bulk fill composites, based on different technologies as specified by manufacturers and compared with one conventional composite

Cavities were prepared such that the gingival margin is placed 1mm above the cement enamel junction (CEJ) because many previous studies have shown that the quality of margin of an adhesive restoration located below CEJ is questionable and so to gain acceptable standards gingival margin is placed in some enamel.¹³

To evaluate the microleakage at the resin tooth interface 50% Silver nitrate solution was used. The reason to use silver nitrate solution is that it is one of the most widely used dyes for evaluation of microleakage, due to better penetration ability of silver ions in comparison with fuchsine and methylene blue.⁸

Use of silver nitrate is considered to be a very severe test because the size of silver ion is too small (0.059 nm) when compared to the size of a typical bacteria (0.5–1.0 μm) and thus it is more penetrative.

In our study the mean score for microleakage was least for SDR followed by SonicFill, FillUp and Filtek Z350. The difference in microleakage among four groups was significant ($p=0.002$)

SDR is a monocomponent composite resin with minimal internal polymerization stresses because of its longer pre gel phase, which is accomplished by using “polymerization modulator” that interacts with camphoroquinone to reduce the contraction modulus and increase the number of linear bonds which results into lower shrinkage stress and preserves polymerization degree which causes less microleakage.⁵

Sonic fill also exhibited less microleakage score because it is a novel resin composite system, which allows bulk placement with a specialized handpiece which delivers sonic energy at varying intensities. On application of sonic energy the incorporated modifier causes the viscosity to drop up to 87% during composite insertion. When the sonic energy is stopped, the composite returns to a more viscous, non slumping state that is more suitable for carving and contouring.¹²

The purpose of including Fillup (Coltene) bulk fill in our study was, it is a dual cure resin composite and the main advantages of using dual-cure composites as restorative material are bulk insertion saves clinical time, with adequate polymerization in deep areas due to chemical curing with low contraction stresses.

But in our study Fillup group scored higher microleakage, the probable reason could be light intensity is highest at the restoration surface decreasing the pre-gel phase and leading to contraction forces and material shrinkage.⁶

Horizontal oblique incremental method was chosen in our study because Mohita Gupta has already concluded in his study that this technique showed least microleakage⁷

Conventional composites showed highest microleakage the reason being that, in the proximal box, the polymerization shrinkage tended to pull this first horizontal increment away from the cervical margin⁵

By analyzing the results of the study it can be

said that recent bulk fill composites have advantages like less time consumption and can efficiently take care of the biggest disadvantage of conventional composites like polymerization shrinkage and gap formation.

Thus the null hypothesis that there is no difference in microleakage of bulk fill and conventional composites stands rejected.

Clinical Implications :

Restoration of class 2 cavities are considered as a great challenge even by experienced clinician. It is considered as a test of skills of practitioner. In class 2 preparations, careful attention is needed in the overall placement, as many of these preparations can be several millimeters in depth and too deep for sufficient penetration of light and proper curing of the resin. Using a conventional/traditional packable composite is time consuming because of various incremental techniques. Despite these various techniques marginal adaptability is questionable, so the incorporation of bulkfill composites in practice to restore class 2 is advantageous as fewer voids are formed, since all of it is placed at one time. This technique is faster and less time consuming as these composites can be cured to a depth of 4 to 5 mm and has an improved marginal adaptation

Conclusion :

Within the limitations of this in vitro study, it can be concluded that in class II restorations, microleakage is observed at at resin tooth interface irrespective of the composites used. But SDR and Sonicfill restorations showed less microleakage when compared to Fillup bulk fill composite and conventional packable composite, Filtek Z-350.

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