

MARGINAL ADAPTATION OF SELF ADHESIVE (SUREFIL ONE) AND CONVENTIONAL BULKFILL COMPOSITES: AN-IN VITRO STUDY

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ABSTRACT

Purpose: To evaluate adaptability of self-adhesive Surefil one and two conventional bulkfill composites Beautifil bulk restorative and Filtek one bulk fill restorative.

Materials and Methods: A total of sixty non carious extracted human premolars were selected for this study. Standardized proximal class II cavity preparations were prepared on distal side and the samples were divided randomly into 3 equal groups (n=20) according to composite used, GI: Beautifil bulk restorative, GII: Filtek One Bulk fill restorative, GIII: Surefil one self-adhesive. All samples were exposed to thermal cycles and were sectioned longitudinally, then were sheltered with gold spray and analyzed on Scanning electron microscope for assessment of marginal adaptation.

Results: Filtek one bulkfill restorative showed excellent adaptation with the walls of the cavity followed by Beautifil bulk and Surefil one self-adhesive. Furthermore, gingival margin showed the highest space among other margins.

Conclusion: Beautifil bulk and One bulk fill performed better results regarding marginal adaptation in all thirds of the cavity of class II cavity. Surefil one showed inferior results than others.

KEYWORDS: Bulk fill, Self-adhesive, Microleakage, Adaptability.

INTRODUCTION

For anterior and posterior restorations, in dental practices, resin-based composites have become the usual filling material. Longstanding clinical studies have established that direct composite materials in posterior teeth influence amalgam restorations (Rathke et al., 2022). The most frequent issues with composite materials are marginal adaptation and microleakage generation, which have an impact on how long dental restorations last (Zhao et al., 2014). Such defects may be caused by inadequate light curing, polymerization shrinkage, degradation of component of adhesive types, differing coefficients of thermal expansion between the dental substrate and the composite, finishing and polishing techniques, and inadequate adhesion at the restoration's interface (Kowan et al., 2012). The long-term durability of adhesively applied restorations depends on marginal integrity. Polymerization shrinkage is a significant issue since it can cause the resin composite-tooth interface to fail, leaving interfacial gaps. Clinically, it might impact a restoration's mechanical strength and durability as well as its sensitivity to cold and discomfort while chewing. (Hany et al., 2016).

Furthermore, advances in composite expertise have shortened application; for example, instead of placing composites in 2 mm thick layers, bulk-fill composites can be placed in 4-5 mm thick layers because of their low polymerization shrinkage stress and high reactivity to light curing (van Dijken and Pallesen, 2017). The high color translucency of these materials allows for deeper penetration of light into them; though, if the cavity is deeper than the maximum depth of cure of 4 mm, another layer must be applied. Reduced light curing time and increased cure depth are both results of the novel polymerization initiating mechanism. These materials' low shrinkage and high filler content result in very low polymerization shrinkage stresses, enabling the application of thicker layers (Abdelrahman et al., 2018). Clinical data extending up to ten years confirmed the bulk-fill composites' safe use as an alternate to conventional posterior composite restorations (Yazici et al., 2022). Another step toward simplification was the improvement of self-adhesive composites that did not require the use of an adhesive, minimizing the time that blood or saliva contamination could jeopardize the restoration.

To make it easier to connect with enamel and dentin, reactive diluents were frequently treated with acidic moieties. Despite the fact that this technique was sold as self-adhesive flowable composites, numerous laboratory experiments have cast doubt on the materials' viability as an alternative to composites that need a separate adhesive (Nakano et al., 2020). Clinical effectiveness of self-adhesive restorative materials is contradictory, particularly in load-bearing areas, has not resulted in a new discovery (van Dijken et al., 2019). To achieve adequate adhesion, the structural monomers can be modified with acidic groups. This approach is taken to its logical conclusion in the Glass ionomer cements contain polyacids (Sidhu and Nicholson, 2016). However, Polyacids are unable to contribute to the radically polymerized network because they lack polymerizable groups. Recently, a high molecular weight

modified polyacid system (MOPOS) was created and patented in order to combine the self-adhesive properties of traditional polyacids found in glass ionomer cements with the crosslinking ability of structural monomers found in composites (Klee et al., 2020). The producer refers to the self-adhesive resin-based bulk-fill restorative under the trade name Surefil One as a self-adhesive composite hybrid (Dentsply Sirona, Konstanz, Germany). According to the manufacturer, the initiator system combines two reducing agents that are utilized in both the dark and light curing processes with the photoinitiator camphorquinone and a persulfate. As a result, the surface areas are both bulk-cured (in the dark) and light-cured (Rathke et al., 2022).

MATERIALS AND METHODS

Materials

Materials used in this study are shown in table 1

N	Composite	Manufacturer	Composition	Filler load
1	Beautifil bulk restorative	Shofu	Bis-GMA, UDMA, Bis-MPEPP, TEGDMA, S-PRG filler based on fluoro-alamino-silicate glass	87% wt 74.5% vol
2	Filtek One bulk fill restorative	3M	non-agglomerated 20nm silica filler, non-agglomerated 4-11 nm zirconia filler, aggregated zirconia/silica cluster filler, ytterbium trifluoride filler consisting of agglomerate 100nm particles. AFM ,AUDMA, UDMA and 1, 12-dodecane-DMA	76.5% wt 58.4% vol
3	Surefil one self-adhesive	Dentsply sirona	Aluminium-phosphor-strontium-sodium-fuoro-silicate glass, water, acrylic acid, polycarboxylic acid (MOPOS), highly dispersed silicon dioxide, self-cure initiator, ytterbium fluoride, bifunctional acrylate (BADEP), , iron oxide pigments, barium sulfate pigment, manganese pigment, camphorquinone, stabilizer	77% wt 58%vol

Samples collection

Sixty extracted intact human upper first premolar were used in this study. Standard box shaped class II cavities that measures 4 mm occlusogingivally, 2 mm buccolingually, 1.5 mesiodistally prepared on the distal surface of the teeth (figure 1) (Nayyer et al., 2019). Following cavity preparation, the teeth were randomly divided (n = 20) into three groups: Group I: Beautifil Bulk Restorative, Group II: Filtek One Bulk fill Restorative, Group III: Surefil one self-adhesive Restorative. For the first and second group (Beautifil Bulk and Filtek One Bulk Fill Restorative) the cavities were dried with triple syringe and brushed using single bond universal (3M, EPSE, Single Bond Universal Adhesive) for 20 seconds. The bonding was given a gentle burst of air drying for 5 seconds, followed by 10 seconds of curing.

Then the cavities were filled in one bulk technique, adapt the restorations to the cavity walls with a carver and the outer walls adapted with translucent strip (figure 2, A) (Abdelrahman et al., 2016) and cured for 20 seconds with the intensity of light was 1200 mW/cm² as measured with a commercial dental radiometer (Denshine, China) using the ramp mode according to the manufacturer's instructions. For the third group of composite (n=20) (Surefil One, Dentsply Sirona) the cavities were dried with triple syringe without any conditioning, etching or bonding. Air-water spray was used to clean the cavities, leaving the cavity surface damp. As directed by the manufacturer, the Surefil One activated capsules were blended in a capsule mixer for 10 seconds. Using a capsule extruder (figure 2,B), the self-adhesive substance was promptly poured into the cavity from the capsule tip, starting supply at the

deepest part of the cavity and maintaining the tip near to the cavity bottom. As the hollow was bulkily filled and shaped with a hand tool, the tip was gradually pulled back.

The outer walls adopted with a transparent Mylar strip and cured for 20 seconds with the ramp mode according to the manufacturer's instructions. The samples were then stored in distilled water for 24 hours and thermocycled for 500 cycles (5- 55 °C) with dwell time for 15 seconds (Patel et al., 2018). After thermocycling teeth sectioned mesiodistally using Minitome (Dorsa. Iran). The samples were then coated

with gold using low vacuum cathodic sputtering, and the scanning The samples were subsequently coated with gold using low vacuum cathodic sputtering, and the marginal seal of the restorations was examined using a scanning electron microscope (TESCAN). For each marginal wall, the peripheral connection was evaluated in turn, 25x and 200x magnifications were employed. NIH Image for the Macintosh served as inspiration for ImageJ, a free Java image processing program used to measure the interface between restorations and the walls (Yantcheva,2021).

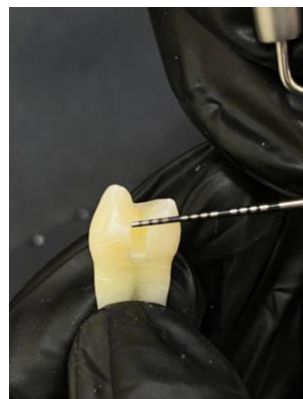
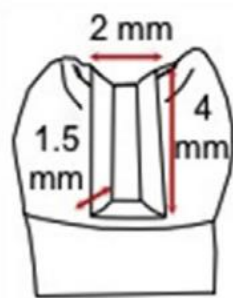


Fig. (1): class II cavity preparation on premolars



Fig. (2): A. Outer walls adapted with translucent strip. B. Capsule extruder (Gun, Dentsply Sirona)

RESULTS

The data in (table 2) and (figure 6) illustrates the total space along the four points from class II

box (coronal, middle, apical and gingival) and it showed that there was a significant difference among study groups.

Table (2): comparison of total space among composite groups (μm)

Study groups	Number	Mean	Std Dev	p-value
Beautiful bulk Restorative	C (n=20)	2.00	1.42	<0.0001
	M (n=20)	0.62	0.53	
	A (n=20)	0.71	0.70	
	G (n=20)	0.71	0.40	
	Total=80	0.86	0.73	
One bulk fill Restorative	C (n=20)	1.17	0.75	
	M (n=20)	0.74	0.73	
	A (n=20)	0.91	0.78	
	G (n=20)	0.53	0.60	
	Total=80	0.83	0.74	
Surefil one self-adhesive	C (n=20)	2.44	1.72	
	M (n=20)	1.95	1.72	
	A (n=20)	1.39	1.23	
	G (n=20)	7.56	6.18	
	Total=80	2.22	1.74	

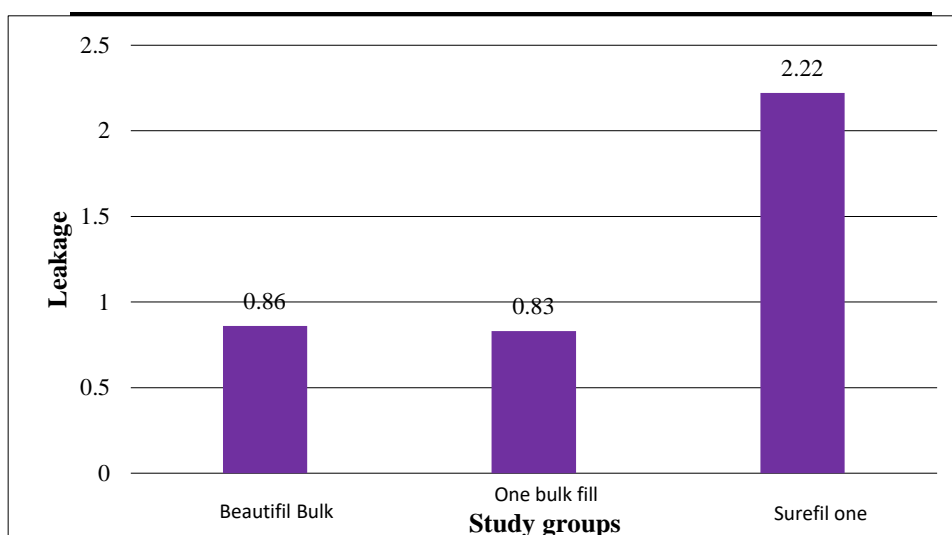


Fig. (6): Total space among composite groups.

Table (3) illustrates the total space between composite types and no significant difference was found between Beautiful bulk Restorative and One bulk fill Restorative. While, there was a significant difference between Beautiful bulk

Restorative and Surefil one self-adhesive. In addition, One bulk fill Restorative and Surefil one self-adhesive were statistically significant difference.

Table (3): Comparisons of total space between study groups(μm)

Level	- Level	Mean (SD)	Mean (SD)	p-Value
Beautiful bulk restorative	One bulk fill restorative	0.86 (0.73)	0.83 (0.74)	0.9018
Beautiful bulk restorative	Surefil one self-adhesive	0.86 (0.73)	2.22 (1.74)	<0.0001
One bulk fill restorative	Surefil one self-adhesive	0.83 (0.74)	2.22 (1.74)	<0.0001

The Tukey test was performed for pairwise comparisons.

Table (4) and figure (7) present the comparison of space among and between composite groups and their thirds. There was a statistically significant difference in coronal third among three groups of composite. Moreover, a significant difference was found in coronal thirds between One bulk fill and Surefill one composites. Additionally, there was a significant difference in middle third among composite groups and comparison between

composite groups in the middle third showed a significant difference between Beautifil bulk and surefil one , One bulkfill and Surefil one. Although, in apical thirds among and between groups no significant difference was found. While, in gingival thirds there was a significant difference among composite groups. Furthermore, Beautifil bulk and One bulkfill , One bulk fill and Surefil one were statistically significantly different.

Table (4): comparison of space among four points of the cavity wall between composite groups (μm).

Level	Mean (Std Dev)		Pairwise comparisons (p-value)
coronal side			
Beautifil bulk (n=20)	2.00 (1.42)	0.0206	Beautifil bulk vs. One bulk fill (0.1535)
One bulk fill (n=20)	1.17 (0.75)		Beautifil bulk vs. Surefil one (0.5925)
Surefil one (n=20)	2.44 (1.72)		One bulk fill vs. Surefil one (0.0174)
middle side			
Beautifil bulk	0.72 (0.67)	0.001 1	Beautifil bulk vs. One bulk fill (P=0.9993)
One bulk fill	0.743 (0.73)		Beautifil bulk vs. Surefil one (P= 0.0034)
Surefil one	2.90 (3.36)		One bulk fill vs. Surefil one (P= 0.0038)
apical side			
Beautifil bulk	0.71 (0.70)	0.0750	Not applicable
One bulk fill	0.91 (0.78)		
Surefil one	1.39 (1.23)		
Gingival side			
Beautifil bulk	0.71 (0.40)	<0.0001	Beautifil bulk vs. Surefil one (P= <0.0001)
One bulk fill	0.53 (0.60)		Beautifil bulk vs. One bulk fill (P=0.9866)
Surefil one	7.56 (6.18)		One bulk fill vs. Surefil one (P= <0.0001)

ANOVA one-way was performed for statistical analyses. The pairwise comparisons were performed in a Tukey test.

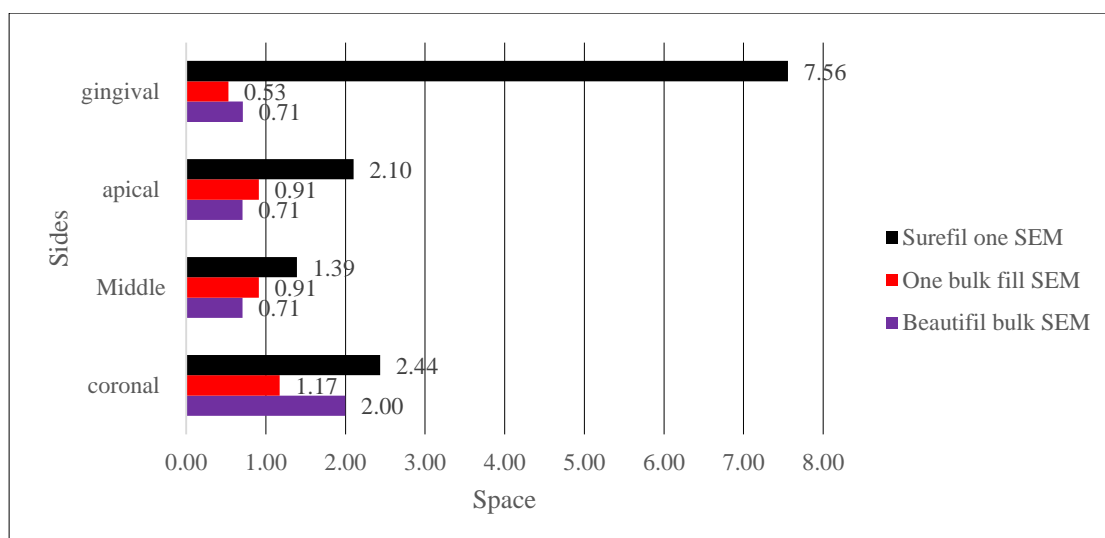


Fig. (7): space of four points of the wall of composite groups

DISCUSSION

Marginal adaptation tests are commonly used to assess composite restoration marginal sealing (Klein et al., 2018). Previous research found that composite restorations had more space at gingival margins than at occlusal margins (Behery et al., 2018). Gingival microleakage is more common in deep class II cavities with gingival margins apical to the CEJ (El-Mowafy et al., 2015). Self-adhesive composites are being developed as a new generation to simplify clinical application, often claiming to be true amalgam replacements that eliminate the by using a self-adhesive restoration, the chance that blood or saliva contamination will weaken the restoration is reduced (Bertolo et al., 2017). The recently introduced self-adhesive composite hybrid Surefil One (Su-O) (Dentsply Sirona), which appears to combine the simplicity of GICs with the stability of resin-based composites, was investigated in this study (Yao et al., 2020).

The accessibility of the cervical area in class II preparation, as well as the problem of moisture control, are additional factors that prove that class II preparation is the best design to estimate the marginal integrity of bulk-fill composite resin (Eltoum et al., 2019). This study used thermocycling to predict and mimic the influence of the oral cavity, as well as to simulate bond degradation over time due to temperature changes in the oral cavity (Mjör, 1998), which discovered that there were wide variations in thermocycling regimens in different studies, implying that the regimen chosen must be arbitrary. Various authors used different dwell times, ranging from as little as 4

s in each bath to as much as 180 s in each bath, with no justification. This study concluded that the dwell time should be clinically relevant and recommended a dwell time of 10 s or less. All of the teeth were thermally cycled between 5°C and 55°C for 10 seconds with a dwell time of 10 seconds and a transfer time of 3-4 seconds (Rossomando and Wandet, 1995). Because of the different coefficients of Thermal stress impairs the marginal integrity of restorations because to the thermal expansion and contraction of hard tooth tissues and composite materials. It stimulates percolation, fatigue the adhesive bond region, and increases or manifests marginal permeability (Mosavi et al., 2013).

In this study, a statistically significant difference found in comparison of total space among composite groups. The highest space seen in Surefil one self-adhesive group (2,22 μm) as showed in table 3. This outcome is consistent with research that demonstrate non-agglomerate fillers degrade under in vitro aging-simulating settings. Additionally, after being stored in water, non-agglomerate characteristics have been reported to deteriorate (Yantcheva and Vasileva, 2016). This has been hypothesized to be caused by the greater space between the matrix and the extremely small particles, which promotes enhanced water sorption and weakens the interaction between the matrix and the particles (da Silva et al., 2008). While, no significant difference found in Beautiful bulk and One bulk fill restorative. However, the decrease in space in cavities filled with other composite materials (Beautiful bulk (0.86 μm) and One bulk fill (0.83 μm)) as showed in (table 3) The fact that this composite has a high filler load and that

nanofiller technologies increase the hygroscopic expansion of the composite, which is the key cause of increased space, may be related to these considerations (Al-Khalidi et al., 2012).

In addition, the marginal gingival wall of the restoration Surefil one which was (7.56 μm) while Beautifil bulk (0.71) and One bulk fill (0.53) as showed in (table 4) the most significantly affected which might be because of enamel is mostly incomplete or absent in this area, additionally, because of the increased organic content of the dentin tissue, the direction of the dentinal tubule, and the difficulty in removing the smear layer, the adhesive bond to the dentin is weaker than the bond to the enamel (Spenser et al., 2010). Gaps between the cavity margin and the composite material are more likely to emerge due to the polymerization shrinkage in this region toward the light source and weaker bond with the dentine. The most recent findings, which demonstrate a considerable impact of aging on the marginal adaptation of composites to the marginal gingival edge, in addition to an increase in distance to the axial wall of the cavity, attest to this fact (Yantcheva et al., 2021). In apical thirds, no significant difference found between groups, while, coronal thirds and middle thirds showed a significant difference found as showed in (table 4), this is due to the enamel layer's thinner thickness at the cervical margin compared to the occlusal margin. Other factors include the distinct histological structure between the occlusal and cervical borders, the organic nature of the dentine substrate at the cervical margins, and the absence of hydroxyapatite crystals there (Abdelrahman et al., 2016). This study agrees with the study of (Yantcheva et al., 2021), while disagree with the results of (Rathke et al., 2022), The clinical performance of the restorations had only a minor decline in marginal quality from 97% acceptable to 96% within the first year of clinical service, according to in vitro data on bond strength and marginal quality of Surefil one restorations after aging operations (Latta et al., 2020).

CONCLUSION

Surefil one showed the highest space in adaptation to cavity walls especially at gingival margin. Beautifil bulk and One bulk fill performed better results regarding marginal adaptation in all thirds of the cavity of class II cavity. Surefil one showed inferior results than

Beautifil bulk and One bulk fill composites. To confirm if these variations can adversely affect the behavior of in vivo restorations, more research is needed.

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