EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
VOL. 70, 3109:3115, OCTOBER, 2024
PRINT ISSN 0070-9484 • ONLINE ISSN 2090-2360
ORTHODONTICS, PEDIATRIC AND PREVENTIVE DENTISTRY
Submit Date : 13-08-2024 • Accept Date : 29-08-2024 • Available online: 1-10-2024 • DOI : 10.21608/edj.2024.308670.3139

LABORATORY EVALUATION OF SHEAR BOND STRENGTH OF SELF-ADHESIVE BULK FILL COMPOSITE IN COMPARISON WITH BULK FILL COMPOSITE

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ABSTRACT

Purpose: To evaluate shear bond strength of a new adhesive restorative material in primary molars in comparison with hybrid composite with universal bond.

Materials and Methods: The study was conducted on twenty teeth categorized into group A: 10 teeth restored with self-adhesive bulk fill composite, while group B: 10 teeth restored with bulk fill resin composite with universal adhesive. The labial surface of twenty mandibular Es were cut to expose a flat surface of dentine. The plastic mold with a central cylindrical cavity was adapted on the buccal surface of the specimen and the restorative materials were placed within the cavity, according to the manufacturers' instructions. All samples were individually and horizontally mounted on a computer-controlled testing machine. The test was done by a compressive mode of load applied at a tooth- resin interface using a mono-beveled chisel until fracture. After debonding, the shear bond strength was registered in MPa.

Results: The independent t-test was used to compare between groups. Shear bond strength of self-adhesive bulk-fill composite was lower than bulk fill composite after applying the adhesive. The mean value was 4.53±1.41 MPa ranged from 2.81 to 6.69 MPa as compared to 1.87±0.94 MPa ranged from 0.75 to 3.60 MPa among bulk fill composite and self-adhesive bulk fill composite groups, P value ≤0.001.

Conclusion: Shear bond strength of self-adhesive bulk-fill composite is significantly lower in than bulk fill composite with a universal adhesive.

KEYWARDS: Bulk-fill composite resin, primary molars, self-adhesive bulk fill composite, shear bond strength, universal adhesive.

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INTRODUCTION

Restoration of the original form and function is the goal of restorative dentistry. Now, adhesion and retention of the material to tooth surfaces are crucial .[1] Interest in durability and dependability of resin composite restorations has been developed along with the demand for more aesthetic treatment choices in restorative dentistry.[2]

Optimum retention and strong bonds are the target of adhesive dentistry. On the other hand, changes in their mechanical properties may be due to any materials applied to teeth surfaces prior to restorative procedures, which could hinder precise bonding.[3] Regarding pediatric dentists, there is an expanding mandate for aesthetic values.[4] These trends have not to be complex.[5]

The material in this analysis contains improved parts which are modified poly acidic groups (MOPOS). They are crucial to create carboxyl-calcium ionic links connecting the material to tooth structure.[6] This restorative material has an initiator system which is defined as a blend of two reducing agents, a persulfate and camphor quinone, which are utilized in light and dark curing steps. Thus, the restorations go through totally curing by light or in the dark. This improved polyacidic approach was developed to associate the self-bonding behaviors of old-style branded polyacids within glass ionomer cements with the linking capacity of main monomers available via composite materials.[7]

The bulk fill composite has been used for direct restoration in posterior teeth since it was presented. It can be placed in bulk due to its chemical structure, which leads to a polymerization contraction decrease and a depth of cure increase; 4 mm single layers can be placed to reduce the procedure time considerably. However, there is no obvious effect of this material about its mechanical properties.[8]

The concept of 'Adhesion–Decalcification', which means that ionic interaction with hydroxyapatite (HAp) and exact practical monomers included in adhesive materials. Such ionic bonds had been demonstrated for 10-methacryloyloxydecyl dihydrogen phosphate to form the self-formed 'nanolayering'. Nevertheless, it the nanolayer presented on teeth surface during using adhesives containing MDP was to be explored. Following common clinical application protocols, it was found that nano-layer was in the hybrid layer and adhesive interface. To create a biodegradation resistant interface, MDP-Ca stable product attached to the self-assembled nanolayer containing two 10-MDP parts.[9]

The shear bond strength (SBS) is the highest force which adhesive joint can manage before failure. Measuring shear strength is by dividing the fracture load by the restored surface cross-section.[10]

Null hypothesis suggested that shear bond strength of self-adhesive bulk fill composite hybrid was comparable to that of bulk fill composite with a universal adhesive, and there was no major difference between them (p value ≥ 0.05).

MATERIALS AND METHODS

Materials

Materials, manufacturer, composition, lot number, and Specification used in this examination are shown in table 1 as per manufacturer.

TABLE (1) Materials consumed in the study:

Material	Manufacturer	Composition	Lot number	Specification
3M™ Single Universal Adhesive	3M ESPE Dental Product St. Paul, MN, USA	Methacryloxydecyl phosphate (MDP) Monomer, HEMA, Dimethacrylate resins, Ethanol, 3M Vitrebond Copolymer, Initiators, Silane, Water.	9122737	One step self-etch adhesive, Light curing
Filtek Bulkfill (FB)	3M, ESPE, St. Paul, MN, USA	UDMA, Ytterbium trifluoride, Bis-GMA, procrylate resins, Bis-EMA, silica zirconia.	A2 Shade, N540884)	Bulk fill composite, Light curing
Surefil One	(Dentsply Sirona, Konstanz, Germany)	Aluminium- strontium- fuoro- phosphor-sodium -silicate glass, ytterbium fuoride, acrylic acid, polycarboxylic acid (MOPOS), bifunctional acrylate, iron oxide pigments, self-cure initiator, manganese pigment, highly dispersed silicon dioxide, camphorquinone, stabilizer, water, barium sulfate pigment	A2 Shade: 1807004175	Self-adhesive bulk fill composite, Dual curing

Methods

First, The Research Ethics Committee, Faculty of Oral and Dental Medicine, Mansoura University evaluated the study proposal, with approval Research number: M21080622. Twenty mandibular primary second molars were collected from Pediatric dental center at the Faculty of Oral and Dental Medicine, Mansoura University and saved from children, in the shedding phase, seeking for extraction that may be due to loosening or over retained molars. Ethical consents on using the teeth for this research were taken from children's parents. Teeth were cleaned from soft and hard tissue debris, then saved in a 0.1% (wt/vol) thymol solution until usage. Immediately in advancement of treatment, the teeth were washed with distilled water for 30 min. Inclusion criteria were intact buccal surfaces, roots not fully resorbed and extraction period not more than 6 months. Exclusion criteria were badly destructed lower second molars, outdated extracted, restored, cracked and molars with anomalies.

The calculated sample size of the study was 10 teeth for each group at 5% level of significance and 95% power of the study, using G*Power 3 sample size calculator, based on mean shear bond strength among group 1 (3.8), SD (1.65) and mean shear bond strength among group 2 (9.7), SD (1.05), mean difference =5.9, Effect size= 2, Z1-$\alpha/2$ =1.96 and Z1-β=1.28, according to Nujella et.al.[11] in 2012. Twenty molars were allocated to be divided into group A: Ten teeth restored by self-adhesive bulk fill hybrid composite (10 molars) and group B: Ten teeth restored by bulk fill composite with universal adhesive (10 molars).

Simple randomization technique was used for including teeth in the test and control groups. Cutting the labial surface of teeth with a diamond disc using a straight low-speed handpiece with water spray to obtain a flat dentinal surface, straight low-speed handpiece [HAY-L-711484, China], in fixed Prosthodontics laboratory at Faculty of Dentistry in Mansoura University. Methacrylate resin (Technovit 4004, Kulzer, Germany) was used to mount teeth within the polypropylene cylinder. The area to be bonded was 3 mm circle. There was no surface treatment before restoration for standardization of the procedures. A mold made of transparent plastic

with a cylinder-shaped cavity (3 mm in diameter and 2 mm in height) was used for placing the restoration. Then, an application of a separating medium [baby oil: Johnson's-0103372, Egypt] by a brush on the wall of the central cavity. Moreover, the mold was adapted on the buccal surface of the specimen.[12]

In group A, the self-adhesive bulk fill composite capsule was firmly pressed by hand then the capsule was placed in the capsule mixer and mixed for 10 seconds at revolution 4200 rpm. After that, the capsule was pressed by capsule extruder (Riva applicator. Then the mold was filled with self-adhesive composite then cured with light curing unit for 20 sec, according to manufacturing recommendation, 1000 mW/cm^2 -1200 mW/cm2 (Guilin Woodpecker Medical Instrument). [L23603535, China]. In group B, the buccal surface was prepared with the self-etching dental adhesives, via brushing the bond for 20 seconds and then scattering the spare amounts with air jet plus 10 s light curing. Then, placing the mold on buccal surface and the cylinder was filled with the bulk-fill RC, followed by curing for 20s. Finally, the mold was removed carefully.

Samples were placed in distilled water bath for 24 hours, the temperature maintained at a controlled 37°C.The universal testing machine, (LLOYD LS500, Southampton, UK) in Dental Biomaterial laboratory at the Faculty of Dentistry in Mansoura University, was used for conducting shear test. All samples were individually and horizontally mounted on a computer-controlled testing machine with a loadcell of 5 kN and data was recorded using computer software (Nexygen 4.2). Tightening screws were used to secure the block embedded tooth with bonded composite to the lower fixed compartment of testing machine. The mono-beveled chisel shaped metallic rod fastened to the upper movable compartment of testing machine for applicating a compressive load at tooth- resin interface, moving at 0.5 mm/min crosshead speed until detachment. The shear bond strength was measured in MPa.[12]

Statistical analysis

The Statistical Package of Social Science (SPSS) program for Windows (Standard version 26) was used for analyzing data. By one-sample Kolmogorov-Smirnov test, the data normality was firstly measured.

Regarding properly distributed data, continuous variables were shown as mean ± SD (standard deviation), The two groups were compared with the independent t-test for parametric data.

The 5% level is the fixed threshold of significance for all the above-discussed statistical tests. When p was less than 0.05, the outcomes were deemed significant ($p \leq 0.05$).

RESULTS

This study was a randomized controlled laboratory trial carried for shear bond strength comparison between self-adhesive composite hybrid and resin-based composite with the universal bonding agent.

This study included 20 extracted primary molars from pediatric dental clinic, Faculty of Dentistry, Mansoura University.

The results in table (2) revealed a significant increase in mean shear bond strength among bulk fill composite group B as judged to self-adhesive composite group A. Mean shear bond strength was 4.53±1.41 MPa ranged from 2.81 to 6.69 MPa as compared to 1.87±0.94 MPa ranged from 0.75 to 3.60 MPa among bulk fill composite and self-adhesive bulk fill composite groups.

TABLE (2) Comparison between self-adhesive bulk fill composite and bulk fill composite regarding shear bond strength in MPa.

Shear Bond Strength	Group A (n=10)	Group B (n=10)	Test of significance	P value
Shear bond strength				
Mean ± SD	1.87±0.94	4.53±1.41	t=4.93	≤0.001*
Range	0.75-3.60	2.81-6.69		

t: Independent t test, *significant p≤0.05

DISCUSSION

Bulk fill composite was used in this study as an evolution in composite technology and have made the procedures easier. While comparing to conventional layering composites, restoration by bulk-fill composite can be in 4 or 5 mm, as there are highly reactive to light during curing and have low shrinkage stress during polymerization.[13] Furthermore, the choice of primary lower second molars in this investigation was based on rejecting different tooth structure (dentine composition, dentine density, dentine histological structure, etc) between first and second primary molars and also the difference between upper and lower second molars, and their effects on the outcomes for a supreme standardization.[14]

In the present study, bulk-fill 3M composite in the control group was chosen due to its ability to provide a more stable and natural interface. It offered great, non-sticky handling with a favorable consistency. Its unique combination of fillers makes it easy to be polished for a promising esthetic result, a good mechanical properties and wear resistance.[15]

Self-adhesive composite was examined because it is appropriate for treating uncooperative patients due to faster procedures.[16] (Modified Polyacid System) (MOPOS) – a unique, patented molecule is the magic ingredient behind this Technology. MOPOS group does chemical bonds which are durable and solid to tooth structure. To link chemically to tooth, the acidic groups play an indispensable role in dissolving ions of calcium from teeth surfaces. To combat etching and be neutral, the acidic part must link to a calcium ion.

Since self-adhesive bulk-fill composites are relatively new materials, also short- as well as long-term clinical data are highly needed.[17] This study was done to evaluate self-adhesive bulk fill composite hybrid as a substitute to conventional bulk fill composite for primary molars.

Researchers were inclined to test shear bond to understand the properties of the adhesive-dentine interfaces to rate the efficacy of adhesives on the bond.[18]

This study was carried out to measure shear bond strength as an ideal restorative material should provide high bond strength.[19]

In this study, it was concluded that self-adhesive bulk fill composite hybrid was lower in shear bond strength than bulk fill composite with universal adhesive , which was in accordance with Mahmoud N [20] in 2023 who reported that the first group (self-adhesive bulk-fill composite) without adhesive application had limited shear bond strength than other tested groups (the second group was restored with self-adhesive bulk fill composite with adhesive application, and the third group was restored by bulk fill restorative with adhesive application) and the results were 4.35, 7.22, 8.67 MPa respectively.

All the materials with an adhesive agent registered higher SBS. Perhaps as a result of the strong bonding that universal adhesives have created with dentin because of the improved wettability of adhesive agents which enables the chemical interaction between the acidic monomer in the adhesive agent and the dentinal calcium for superior micromechanical retention.[21]

In addition, Richler et.al.[22] in 2024 also explained that self-adhesive composite showed the tiniest shear bond strength values because the area was not wholly dry.

On the contrary, these results were in contrast to Francois et.al.[23] study in 2021 because they found that when the adhesive was not applied to the surface before restoring the teeth by (Surefil One), it showed high shear bond strength most likely due to the fact that adhesion depended primarily on the mean polyaacidic group with a high molecular weight that could help through smear layer hybridization and an ionic interactions between MOPOS and dentinal calcium.[24]

Thus, Null hypothesis is rejected as self-adhesive bulk fill composite hybrid mostly implies a significant decline in shear bond strength than bulk fill composite with universal adhesive. In today's era, people are blindly running behind aesthetically pleasing procedures for the sake of acceptance in society where in they lose their authenticity. Hence, we were forced to think that if the goal of modern adhesive dentistry is to save or salvage as much of a patient's natural dentition as possible.[25]

CONCLUSION

According to the parameters of this research, it revealed that:

Self-adhesive bulk fill hybrid composite is meaningfully lower in shear bond strength than conventional bulk fill composite.

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