



COMPARATIVE EVALUATION OF SHEAR BOND STRENGTH BETWEEN SELF-ADHESIVE RESIN COMPOSITE AND DIFFERENT ADHESIVE SYSTEMS TO DENTIN AT DIFFERENT STORAGE TIMES (IN VITRO STUDY)

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ABSTRACT

Aim: This study was directed to evaluate the shear bond strength between self-adhesive resin composite and different adhesive systems to dentin at different storage times. **Materials and method:** Extracted human premolars teeth (n=99) were used, where their occlusal surfaces were prepared. Specimens were divided into three equal main groups according to the adhesive system used. (A1; Self-adhesive flowable composite, A2; One step self-etch adhesive system, A3; Two-steps etch and rinse adhesive system). Then each main group was subdivided according the storage time into three equal subgroups (B1; 24 hours, B2; Three months, B3; Six months) The final assembly was mounted on a universal testing machine (Lloyd instruments, LR 5K, England). A shear load was applied at a crosshead speed of 0.5 mm/min. until failure occurred. The data was recorded using computer software (Nexygen-MT Lloyd Instruments). **Results:** A statistically significant difference in shear bond strength was found between all the adhesive groups. After instrumentation where ($p \leq 0.001$). Also, a statistically significant difference in shear bond was found between three months and six months groups for all adhesives where ($p \leq 0.001$). **Conclusion:** Self-adhering flowable composite has poor bond strength to dentin and storage in water for long periods has a highly significant adverse effect on bond strength.

INTRODUCTION

Flowable composite appeared in the 1990s as an important advancement in restorative dental materials⁽¹⁾. They have excellent handling properties, low viscosity, and superior injectability. Easy handling is a highly desired characteristic because it reduces the working time of clinicians and chair side time of patients⁽²⁾. Following the same characteristics, a new self-adhering flowable composite, Vertise Flow, was recently introduced in the market. These adhesive-free composites are claimed to rely on chemical and micromechanical interaction between material and tooth structures or other substrates, achieved with incorporation of an acidic adhesive monomer into the flowable composites^(3,4). The clinical success of flowable composite depends on the ability of the material to adhere to the dental

surface^(5,6). There is a consensus that in vivo trials are imperative for evaluating the performance of dentin bonding agents in the oral environment⁽⁷⁾. However, due to the rapid development and introduction of these materials on the market, it has become necessary to find simple and fast methods for evaluating their effectiveness, since clinical trials are time consuming and too costly^(8,9). Therefore, in vitro bond strength tests have been done, the most popular being the shear method⁽¹⁰⁾ So shear bond strength test is comparatively simple, reproducible, and commonly accepted in helping to investigate bonding performance of this new self-adhering flowable composite⁽¹¹⁾. Thus the experimental design of the present study aimed to evaluate the shear bond strength between self-adhesive resin composite and different adhesive systems to dentin at different storage times.

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MATERIALS AND METHODS

A total ninety nine human molar teeth were used in this study. All the selected teeth were free from decay, abnormalities or restorations. The teeth were randomly divided into three equal main groups (n=33) according to the adhesive system used, group1: (A1) self-adhesive flowable composite as adhesive system and a restorative material, group2: (A2) one step self-etch adhesive system and flowable resin composite, and group3: (A3) Two-steps etch and rinse adhesive system and flowable resin composite. Each group was then divided equally into three subgroups according to aging periods, subgroup1: (B1) aged for one day, subgroup2: (B2) for three months and subgroup3: (B3) for six months. Each tooth was vertically embedded into self-curing acrylic resin up to the level of the cervical line with their occlusal plane being parallel to the acrylic resin base. The occlusal surface of each tooth was then ground flat, parallel to the occlusal surface and perpendicular to the long access of the tooth at level of 1 mm. below dentino-enamel junction using a cylindrical diamond stones mounted in high speed hand piece accompanied with copious air-water spray. Specially designed machine milled split Teflon mold of 3 mm internal diameter and 2 mm height. All materials in this study were used according to the manufacturer's instructions. All samples were stored in distilled water at 37°C in incubator to regulate the aging temperature 37°C either for one day, three months or six months. The storage media was changed every week for all the aged specimens. To simulate the oral condition during storage time, the specimens were thermocycled

between 5°C and 55°C for 100 cycles (one minute for each). After the water storage for each group all of its samples were individually and vertically mounted on a computer controlled materials testing machine (Model 3345; Instron Industrial Products, Norwood, USA) with a load cell of 5 kN and data were recorded using computer software (Bluehill Lite; Instron Instruments). Data analysis was performed in several steps. Initially, descriptive statistics for each group results. One way ANOVA followed by pair-wise Tukey's post-hoc tests were performed to detect significance between each adhesive approach and storage time subgroups. Two-way ANOVA test was done for comparing adhesive and storage effect on bond strength. Statistical analysis was performed using Asistat 7.6 statistics software for Windows (Campina Grande, Paraiba state, Brazil). P values ≤ 0.05 are considered to be statistically significant in all tests.

RESULTS

There is statistically significant difference between all adhesive systems, the self-adhesive flowable composite recorded the lowest shear bond strength value and the total-etch adhesive system recorded the highest shear bond strength value ($p \leq 0.001$). Also, there was statistically significant difference between all adhesive systems after storage time of six months in distilled water. Finally, the highest shear bond strength value was recorded for total-etch adhesive system after 24 hr. of storage and the lowest shear bond strength value was recorded for self-adhesive flowable resin composite after six months of storage.

The mean and standard deviation values were calculated for each group.

Item		Adhesive system approach			ANOVA
		Self-adhere	Self-etch	Total etch	P value
Storage time	One day	8.13 ^A _b ± 0.87	12.03 ^A _a ± 1.4	17.96 ^A _a ± 2.15	.0006*
	Three months	8.004 ^A _c ± 1.1	11.27 ^A _b ± 1.5	17.94 ^A _a ± 2.2	.0004*
	Six months	3.57 ^B _b ± 0.51	8.28 ^A _a ± 2	14.63 ^B _a ± 1.1	.0042*
ANOVA	P value	.0297*	0.0138*	.2944ns	

DISCUSSION

The total etch adhesive system has higher shear bond strength than the other adhesive systems through the storage time. Probably, the poor performance of self-etching adhesive and self-adhering flowable resin composite is related to the little micromechanical interaction of their resin components with dentin. This confirmed with the results obtained by Mauro et al ⁽¹²⁾ who found that, the alterations in enamel and dentin generated by the acidic primers of self-etching systems are worse than those obtained with phosphoric acid etching. This agreement with El-Malky et al ⁽¹³⁾ and Zeidan et al ⁽¹⁴⁾ whose found that the higher bond strength values for the etch and rinse adhesive system can be explained by the more micro-retentive tooth surface obtained when the tooth structure was etched with phosphoric acid as compared to when the tooth structure was etched by the self-etch adhesives. This disagreement with Kwong et al ⁽¹⁵⁾ who found that higher bond strength values for self-etch adhesive system. This may be due to ability of self-etching adhesives to make chemical bonding with dentin.

Self-adhesive flowable composite showed the lowest shear bond strength in comparison with the different adhesive systems used in this study, because it's bonding mechanism relies on the adhesive monomer glycerol phosphate dimethacrylate (GPDM). Specifically, the phosphate group of GPDM is responsible for acid etching. The dimethacrylate functional groups are involved in cross-linking reactions with other methacrylate monomers, thus providing mechanical strength to the adhesive material (Kerr Technical Bulletin). Based on the pH declared from the manufacturer (1.9), Vertise Flow can be expected to interact with dental substrate similarly to a mild self-etch adhesive not as the total etch adhesive ⁽¹⁶⁾. This also confirmed with Poitevin ⁽¹⁷⁾ and Bektas ⁽¹⁸⁾.

Optibond all-in-one showed higher shear bond strength than Vertise Flow as it has not filler as Vertise Flow according to Miyazaki et al ⁽¹⁰⁾ who suggested that filler in the adhesive resin might decrease the wetting of the dentin surface because of the higher viscosity of filled resins. This would decrease the penetration of monomers, thus reducing the shear bond strength. This study antagonist with Bui et al ⁽¹⁹⁾.

This study showed that shear bond strength of all the adhesive systems decreased after six months of storage time. This might be due to hydrolytic degradation of the resin and collagen fibers in the submicron spaces of the hybrid layer increase with increased exposure to water ⁽²⁰⁾. In fact, during long-term water storage, the resin absorbs significant amount of water and consequently swelling of the resin may result in the closure of any space between the bonding resin and dentin surface. Conversely, stresses may simultaneously be induced at the bonding resin-dentin interface, which may pull the collagen fibers into the hybrid layer and resin, leading to tearing along the bonded interface as the collagen fibers become weaker over time from hydrolysis. The increase storage period allow increase water uptake, that lead to increased permeability and increase the hydrolytic degradation of the material ⁽²¹⁾.

CONCLUSION

Under the circumstances of this study, the following conclusions were suggested:

- 1- Total- etch adhesive system has higher bond strength to dentin than self-etch adhesive system and self-adhesive flowable resin composite.
- 2- Self-adhering flowable composite has poor bond strength to dentin.
- 3- Storage in water for long periods has a highly significant adverse effect on bond strength of all tested materials.

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