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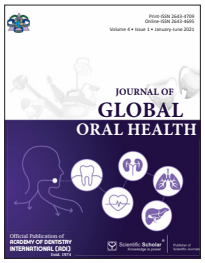

Research Article

Comparative evaluation of bond strength of three self-adhering flowable composites to sound and demineralized enamel – An *in vitro* study

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ABSTRACT

Objectives: The purpose of this study was to determine bond strength of three self-adhering flowable composites.

Materials and Methods: Mean tensile bond strength was measured in three groups – Group A – Constic, Group B – Dyad Flow, and Group C – Fusio Liquid Dentin on sound and demineralized primary teeth. Fracture pattern was studied using a stereomicroscope for each sample and in classified as adhesive, cohesive, or mixed fracture.

Results: Mean tensile bond strength in sound enamel of Group A (Constic) was found to be 10.79 + 4.24, Group B (Dyad Flow) was 10.30 + 4.63, and of Group C (Fusio Liquid Dentine) was 11.87 + 4.45. No significant difference was found between the three groups (f = 0.327 and *P* = 0.724). However, a significant difference was found with demineralized enamel in three groups. Constic and Dyad Flow exhibited adhesive fracture pattern in majority of samples on sound enamel, whereas Fusio Liquid Dentin had mixed fracture pattern. On demineralized enamel, Constic exhibited adhesive fracture pattern majorly, whereas Dyad flow demonstrated mixed pattern and Fusio Liquid Dentin had more of cohesive fractures.

Conclusion: Constic, Dyad Flow, and Fusio Liquid Dentin can be used instead of conventional pit and fissure sealants or in small occlusal cavities in primary teeth as a single step material.

Keywords: Fracture pattern, Self-adhering composite, Tensile bond strength

INTRODUCTION

Restorative dentistry is a balance of ever-evolving materials and techniques forming the core of pediatric dental practice. Various restorative materials available to the pedodontists include glass-ionomer cements, resin modified glass-ionomer cements, and resin-based composites.[1]

Pedodontists are often challenged by unfavorable factors such as patients' age and uncooperative behavior which may adversely affect the treatment outcome. Primary dentition especially molars are highly susceptible to caries due to their fissured occlusal surfaces, broad, and flat interproximal areas. For restoration of small-sized cavities, flowable composites are the materials of choice due to their direct injectability and better flow compared to filled composites.[2]

Usage of composite resins has increased considerably with the progressive research to improve their clinical performance and esthetic properties. Direct restorative composite resins are categorized as: hybrid, nano-filled, microfill, packable, and flowable composites.[1] Recently,

self-adhering flowable composites were introduced to overcome the disadvantages of the total-etch systems providing the merits of both adhesive and restorative material. These flowable composites have bonding agent incorporated within, eventually saving chair-side time, and minimizing handling errors.

Very few studies using self-adhering flowable composites have been conducted on primary teeth. Hence, the purpose of this study was to compare the bond strength of three different self-adhering flowable composites, Fusio Liquid Dentin, Dyad Flow, and Constic to sound and demineralized primary enamel and to observe the associated fracture pattern, respectively.

MATERIALS AND METHODS

This study was conducted in the Department of Pedodontics and Preventive Dentistry, in association with the Department of Oral Pathology and the Research Centre of I.T.S. Dental College, Hospital and Research Centre, Greater Noida.

Sample size

Sixty, freshly extracted human primary molars were used which were indicated for extraction if close to natural exfoliation, over-retained, and for serial extraction. Teeth with caries, developmental anomalies, and cracks or fractures during extraction were excluded from the study. The selected teeth were cleaned using ultrasonic scalers and stored in 10% Formalin solution at room temperature.

The teeth were randomly and equally divided into three groups of 20 each. Each group was further divided into two groups of 10 teeth for evaluation of tensile bond strength and failure mode of the three different composites on sound and demineralized enamel. Group A was treated with Constic, Group B with Dyad Flow, and Group C with Fusio Liquid Dentin. Subgroups A1, B1, and C1 involved sound enamel and subgroups A2, B2, and C2 were subject to a cariogenic challenge to represent demineralized enamel.

Evaluation of tensile bond strength on sound enamel

Occlusal surfaces of teeth were cleaned using an ultrasonic scaler tip and distilled water. Abrasive silicon paper of grits – 100, 220, 320, 400, and 600 were used to reduce enamel by 0.5 mm and achieve a flat surface. The teeth were cleansed, rinsed, dried, and embedded in acrylic blocks of standardized size. An orthodontic elastic of internal diameter 2.5 mm and approximately 3 mm height was seated on the enamel surface and filled with composite material to be tested. U-Loops of 0.25 mm ligature wire were incorporated within this composite and incrementally light cured according to manufacturer's instructions, using spectrum 800 (Dentsply) curing unit with an intensity of 400 m W/cm^2. Subgroups A1, B1, and C1 were evaluated for tensile bond strength using the Universal Testing Machine.

Evaluation of tensile bond strength on demineralized enamel

Cariogenic challenge

Teeth in demineralized groups were subjected to a cariogenic challenge by pH cycling before restorative procedures. They were immersed in 10 ml of demineralizing solution (2.2 mM $CaCl_2$, 2.2 mM NaH_2PO_4, 0.05 M acetic acid adjusted to pH 4.8 with 1 M KOH) for 14 cycles of 8 h. After completion of demineralization, the samples were prepared following the same procedure as for sound enamel including enamel surface flattening.

The orthodontic elastics were removed before testing and specimens were placed in the universal testing machine. The bonding interface was loaded in tensile with a device constructed to direct the tensile force with a cross head speed of 0.20 mm/min until failure was observed. Tensile bond strength was determined in MegaPascals (MPa) by dividing failure load with the cross-sectional area (bonded area) of the composite.

Evaluation of failure pattern

The fracture patterns of failure – adhesive, cohesive, or mixed, of the three self-adhering flowable composites were examined using a stereomicroscope for all groups at 50× and 100× magnification.

Statistical analysis

The data were evaluated using SPSS version 21.0. One-way ANOVA test was used to find the intragroup level of significance and Mann–whitney U-test was used for intergroup comparison. The inter group distribution of the fracture patterns was compared using the Chi-square test. The level of significance was set as $P \leq 0.05$.

RESULTS

Mean tensile bond strength on sound enamel of Group A (Constic) was found to be 10.79 + 4.24, Group B (Dyad Flow) 10.30 + 4.63, and Group C (Fusio Liquid Dentine) was 11.87 + 4.45. No significant difference was found between the three groups ($P = 0.724$) [Figure 1a].

Intergroup comparison between constic, Dyad flow and Fusio Liquid Dentin showed in sound enamel significant difference between the three composite groups [Table 1].

Comparison for mean tensile bond strength on demineralized enamel showed a significant difference in mean Mpa between the groups [Figure 1b].

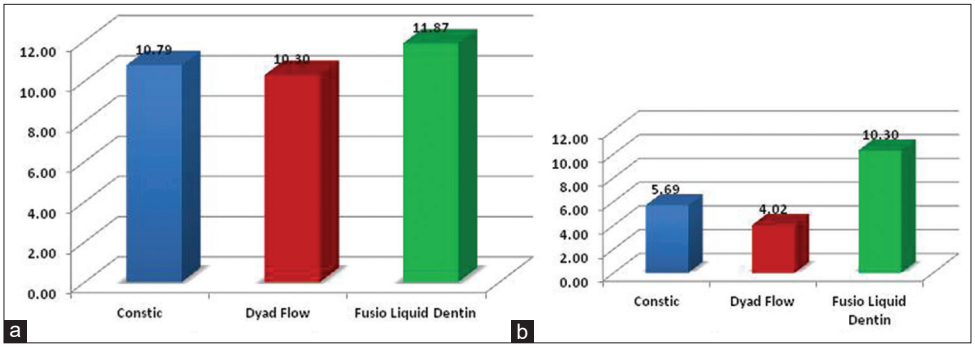

Figure 1: Graph showing (a)Mean tensile bond strength in MegaPascals (MPa) (sound enamel) and (b) mean tensile bond strength in MPa (demineralized enamel).

Intergroup comparison on demineralized enamel showed significant differences between the three groups (f value 5.107 and *P* value 0.013) [Table 2].

MPa (Demineralized Enamel) in Fusio Liquid Dentin was found to be higher [Table 3] compared to Dyad Flow. Significant difference was found on comparing Groups B and C, whereas no significant difference was seen on comparing A and B and A and C.

Adhesive bond was significantly more among Constic and Dyad Flow, whereas the mixed bond was higher among Fusio Liquid Dentin [Figure 2a].

Adhesive bond was significantly more with Constic, Cohesive bond was significantly more among Fusio Liquid Dentin and the mixed bond was significantly more among Dyad Flow [Figure 2b].

Table 1: Mean tensile bond strength of Constic, Dyad Flow and Fusio Liquid Dentin in Sound Enamel.

	MegaPascals (Sound Enamel)	
	Mean difference	***P*-value**
Constic versus Dyad flow	0.49	1.000
Constic versus Fusio Liquid Dentin	−1.08	1.000
Dyad flow versus Fusio Liquid Dentin	−1.57	1.000

Table 2: Mean tensile bond strength of Constic, Dyad Flow and Fusio Liquid Dentin in Demineralized Enamel.

	MegaPascals (demineralized enamel)		
	Mean	**Standard deviation**	***P*-value**
Constic	5.69	3.97	0.013*
Dyad Flow	4.02	3.01	
Fusio Liquid Dentin	10.30	6.10	

Table 3: Inter group comparison of mean tensile bond strength in Demineralized Enamel.

	MegaPascals (demineralized enamel)	
	Mean difference	***P*-value**
Constic versus Dyad Flow	1.67	1.000
Constic versus Fusio Liquid Dentin	−4.61	0.123
Dyad Flow versus Fusio Liquid Dentin	−6.28	0.029*

DISCUSSION

Self-adhering flowable resin-based composites being moisture tolerant are less technique sensitive and have a wide use in pediatric dentistry including preventive resin restorations, pit and fissure sealants, cavity liners, minimally invasive Class II restorations, and Class V abfraction lesions.[3,4]

In the present study, among the three self-adhering composites, Dyad Flow™ had the least bond strength possibly due to higher viscosity, lack of solvent, lower wettability, chemical nature of matrix monomers, and matrix filler content.[5] These results were in concurrence with studies by Jiale *et al.*[6] and Poitevin *et al.*[7] that showed the microtensile bond strength of Fusio Liquid Dentin (23.6 MPa) was higher than Dyad Flow (13.1 MPA) on dentin. However, contrary results were found in a study by Altunsoy (2015) *et al.*,[8] where microtensile bond strength of Dyad Flow was higher than that of Fusio Liquid Dentin.

It is seen that the self-etch primers exhibit tensile bond strength comparable to desirable value (20–37 MPa) in permanent teeth but in primary teeth enamel, total etch technique exhibits significantly higher bond strength.[9] Furthermore, bond strengths in enamel differ from dentine due to absence of moisture in enamel after surface drying, justifying the result obtained from present study.[9]

The fracture pattern with different composites in this study was categorized into adhesive, cohesive, and mixed failure

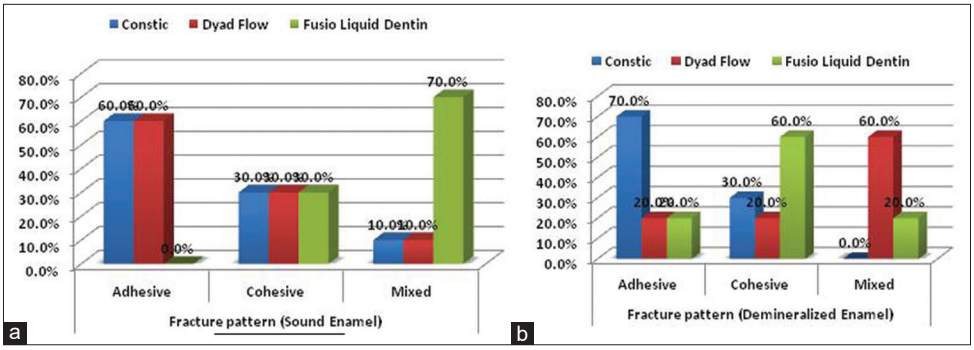

Figure 2: Graph showing (a) Distribution of fracture patterns in sound enamel and (b) distribution of fracture patterns in demineralized enamel.

based on the previous work studies by Woronko *et al.* and Yuan *et al.*[10,11]

More adhesive failures with sound enamel were seen in Constic and Dyad flow, whereas mixed failures were predominant with Fusio Liquid Dentin which could be due to high stress areas at substrate or interface in specimens with larger surface areas.[12]

The difference in fracture patterns observed in this study is in concurrence with results obtained by Agostini FG *et al.* (2001),[1]showing more adhesive fractures and mixed fractures in primary teeth enamel using self-etch adhesives. These results are also similar to a study by Ramires-Romito *et al.*,[13] in which tensile bond strength in primary teeth reported higher mixed fractures with the use of self-etch adhesive, two total etch adhesive systems, and a conventional sealant.

CONCLUSION

From the present study, following conclusions were drawn:

1. All three tested materials had comparable tensile bond strength on primary sound enamel, while Fusio Liquid Dentin exhibited significantly highest tensile bond strength on demineralized primary enamel.
2. Constic and Dyad Flow had more adhesive fracture pattern on primary sound enamel than Fusio Liquid Dentin with high mixed fracture pattern.
3. All three materials can be used as single step pit and fissure sealants and in small occlusal cavities as a single step restorative material.

Limitations

- The study was done *in vitro,* but several factors such as isolation and cooperation of the patient clinically will alter the physical properties of the material.
- This study was limited to primary teeth; hence, further research in permanent teeth is required for exploring its clinical applicability.

Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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