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Shear Bond Strength Assessment of Vita Suprinity Ceramic to Enamel and Dentine Using Three Different Resin Cements

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ABSTRACT

Purpose: The current study aimed to asses shear bond strength of Vita Suprinity ceramics bonded to dentine and enamel utilizing three different types of resin cements. **Materials and Methods:** Sixty ceramic samples (Vita Suprinity) were divided according to the tooth substrate into two equal groups (thirty samples cemented to enamel substrate and thirty samples to dentine substrate). Each group was divided into three subgroups (n=10) according to cementation mechanism: SubgroupI; Etch &rinse mechanism (Duolink resin cement. All bond universal and acid etch), SubgroupII; Self etch mechanism (Bifix QM resin cement and futura bond) and subgroupIII; Self-adhesive mechanism (Relyx Unicem). The cemented specimens were thermocycled then shear bond strength was measured. **Results:** By comparing cementation protocols the total etch mechanism recorded the highest bond strength while the self- adhesive mechanism recorded the lowest strength. Comparing substrates, the enamel results were significantly higher than that of dentine results**. Conclusion:** Although the self etch and self-adhesive resin cements are simple in manipulation, their bond strength is lower than that of total etch technique so they need improvement.

KEYWORDS

Dental ceramics, Cements, shear bond strength.

INTRODUCTION

There is a dramatic increase of using (CAD/CAM) systems in dentistry to fabricate precise and accurate indirect restorations to restore patients' oral functions and esthetics. Ceramic is one of the primary materials used as anterior esthetic restorative material, due to its color and optical properties [1].

- Paper extracted from Master thesis titled "Shear Bond Strength Assesment of Vita Suprinity Ceramic to Enamel and Dentine Using Three Different Resin Cements"

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Lithium disilicate glass ceramics (IPS emax CAD) was introduced in 2007 [2]. In 2013; Zirconia reinforced lithium disilicates (Vita Suprinity) were introduced. This material comprises a lithium disilicate ceramic that is reinforced by about 10% zirconia crystals by weight [3, 4].

A lot of factors affect the durability of the restoration as; structure of tooth surface, preparation and design, the used ceramic type, the type of cement used, tooth morphology and functional and parafunctional activities of the patient [5].

The enamel preparation is important to remove the surface enamel which is hyper mineralized and resist the acid etching. The enamel etching is the base of bonding enamel to resins due to increasing the surface energy and surface area of enamel [6].

The challenges faced with dentine bonding are more complicated than those faced with enamel bonding. Dentine is characterized by high amount of organic substance and water that interfere with diffusion of monomer [7].

Cementation is an important step for insuring the indirect restorations longevity. Dental cements are categorized into conventional cements as zinc polycarboxylate and glass-ionomer cements and polymerizing cements such as resin modified glass-ionomer and resin cements [8].

Adhesive materials have transformed the dental field in terms of conservation of tooth structure because of less invasive procedures and allowing bonding between indirect restorations and tooth structure. The preferable classification of resin cements is that depends on bonding mechanism: total-etch, self-etching, and self-adhesive [9]. Shear bond strength is usually used for evaluation of the bonding system [10,11].

MATERIALS AND METHODS

1- Fabrication of ceramic samples

Sixty ceramic samples of Vita Suprinity were cut at dimensions (3x4x2) mm with (Isomet1000; Buehler,Lake Bluff, IL). All samples were crystallized, finished and polished according to manufacturer instruction.

2- Experimental design:

The sixty ceramic samples were divided into two groups according to tooth substrate (n=30)

- Group I: Samples cemented to enamel.
- Group II: Samples cemented to dentine.

The two groups were then subdivided into three subgroups according to type of cement (n=10).

Subgroup A (n=10): Etch and rinse mechanism of bonding.

Subgroup B (n=10): Self etch mechanism of bonding.

Subgroup C (n=10): Self- adhesive mechanism of bonding.

3- Preparation of tooth substrate:

Sixty freshly extracted maxillary premolars were utilized within one month in this study. All teeth were obtained from patients after gaining a consent form describing their approval of using their teeth in the study. The teeth were randomly divided into two groups; half of the teeth were prepared within dentine. The other half were prepared within enamel. Buccal surfaces of the teeth were ground to obtain flat dentine and enamel surfaces. The roots of the teeth were cut at CEJ. Then the crowns of the teeth were placed within acrylic molds with their buccal surfaces directed upward.

4- Cementation of the ceramic samples:

Firstly, ceramic samples were conditioned with 9.5% hydrofloric acid for 20 seconds then rinsed and dried. Silane coupling agent was applied for 60 seconds. Teeth were conditioned according to the type of cement (total etch technique: Duolink cement, All bond universal and acid etchant (Bisco Inc., Schaumburg, U.S.A), Self- etch technique: Bifix QM and Futura bond (Voco, Germany) and

Self-adhesive technique: RelyX Unicem (3M ESPE, Germany). Cementation initialized under cementing device where the initial curing occur under the load for 10 seconds then further curing using light curing unit for 20 seconds.

5- Thermocycling procedures:

The samples were subjected to thermal aging process for 500 cycle. Dwell times were 25 seconds in each water bath with a lag time 10 seconds. The low-temperature point was 5˚C and the high temperature point was 55 ˚C.

6- Shear bond strength test:

All samples were mounted on the testing machine ((Model 3345; Instron Industrial Products, Norwood, USA) with a loadcell of 5 kN and data were recorded using computer software (Bluehill Lite; Instron Instruments). Jakobe's chuck was used as sample holder. Shearing test was done by compressive mode of load applied at tooth-ceramic interface using a mono-bevelled chisel shaped metallic rod attached to the upper movable compartment of testing machine traveling at cross-head speed of 0.5 mm/min. The load required for de-bonding was recorded in Newton. The bond strength is calculated by dividing the load at failure by the bonding area.

7- The failure mode:

The electron microscope was used for photo-graphing the debonded surfaces to detect the mode of failure, which classified into adhesive, cohesive and mixed.

RESULTS

Data were analyzed in several steps. Firstly, descriptive statistics for each group results. Two-way ANOVA followed by pair-wise Tukey's post-hoc tests were used for detection of significant effect of variables (material and aging). One-way ANOVA and student t-test was done between main groups and subgroups. Chi square was carried out between failure modes.

Shear bond strength:

Descriptive statistics showing mean values and standard deviation of shear bond strength test results measured in (MPa) as function of cement groups and substrate are summarized in table (1).

Failure mode analysis

Chi square test revealed significant difference in failure mode distribution between groups that showed in table (2)

Table (1): *Shear bond strength test results (Mean±SD) as function of cement groups and substrate type*

Variables			Descriptive statistics			t-test
			Mean±SD	95% confidence intervals		P value
				Lower	Upper	
Cement group	Total etch	Enamel	16.75^{A}±1.32	15.8	17.69	<0.0001*
		Dentin	13.48^{B}±0.7	12.97	13.98	
	Self etch	Enamel	9.79^{D}±0.62	9.34	10.23	<0.0001*
		Dentin	11.29^{C}±0.52	10.92	11.67	
	Self adhesive	Enamel	8.28^{E}±0.46	7.95	8.61	<0.0001*
		Dentin	5.55^{F}±0.76	5.01	6.09	
ANOVA test		P value	<0.0001*			

Different superscript upper case letter in the same column revealed statistically significant difference ($p < 0.05$)
**significant ($p < 0.05$)*

Table (2): *Frequent distribution of failure mode pattern (%) for all cement groups as function of bonding substrate*

Variables		Failure mode pattern			Statistics
		Adhesive	Cohesive	Mixed	P value
Total etch	Enamel	0%	0%	100%	<0.0001*
	Dentin	20%	0%	80%	
Self etch	Enamel	20%	0%	80%	
	Dentin	20%	0%	80%	
Self adhesive	Enamel	0%	0%	100%	
	Dentin	20%	0%	80%	

** significant (p<0.05)*

DISCUSSION

Ceramic is one of the primary materials used as a definitive anterior esthetic restorative material, due to its color and optical properties; simulating natural teeth, good wear resistance, and color stability.[12] Lately, the manufacturers claim that the newly introduced all-ceramic systems in dentistry have high translucency which is comparable to that of feldspathic porcelains accompanied by improved mechanical resistance. Accordingly, for a correct selection, longevity and esthetics have to be considered from the main parameters.

Recently introduced zirconia reinforced lithium disilicate ceramics (ZLS) showed a positive combination of the material characteristics of zirconia which is very strong and glass ceramics which have superior esthetics therefore Vita Suprinity ceramic was used in the present study [13].

Proper adhesive cementation is important between indirect ceramic restorations and dental tissues especially for minimally retentive preparations as veneers, inlays, onlays or any partial coverage restoration [14].

There are three types of resin cements in the market classified according to their adhesive properties. These are the etch-and-rinse resin cements, also called total-etch cements, the self-etch resin cements, and the self-adhesive resin cements [15]. In this study the three types of cements were used.

The current study confirms that the shear bond strength is affected by the cementation protocol and substrate.

Thermal cycling is an important factor that was used in this study in order to simulate oral environment. 500 Cycles used in the study were equivalent to 6-months aging in oral environment.[16]

Concerning the influence of the substrate on shear bond strength, the enamel groups exhibited significantly higher shear bond strength values than dentin groups. (table (1) The cause of this may be attributed to the presence of higher organic components, tubular configuration, fluid pressure and the lower surface energy of dentin, which make difficulty in bonding of dentine more than enamel[17].

These results were in agreement with a previous study that concluded that dental substrate had a high effect on the bond strength, even more than the adhesive system that can be used, so the margins of indirect restorations should be in enamel to obtain greater adhesion reliability [18].

In relation to the type of cement, the total etch system presented the highest bond strength values with enamel and dentin substrates, where its bond strength to enamel was higher than that of dentin. (table 1)

Many studies showed the same results of etch-and-rinse cementation technique that had the highest SBS to enamel due to its higher etching capability. Etch and rinse technique is preferred for bonding to enamel, since the micromechanical interaction provides a long-lasting bond to enamel [19, 20].

These results are predictable from review of other studies. In 2005 and 2019 reviews, [21,22] that established that the total etch adhesives are the best

approach for durability and that any simplified type of adhesives, such as one-step all-in-one adhesives, results in reduction of bonding effectiveness and longevity.[23]

Results of the current study revealed that the lowest shear bond strength values were that of self-adhesive resin cement which needs no treatment of the tooth substrate as instructed by the manufacturer.

These results were in agreement with a study which concluded that simplified adhesive systems reduce operating time by excluding the pretreatment steps of the substrate. On the other hand, the quality of the interface formed is affected by their high viscosity that affects the infiltration of the monomers into the tissues, so the penetration becomes shallow despite its low initial PH. [24]

With respect to this, there were two previous studies concluded that the self-adhesive systems cant form a true hybrid layer, which is confirmed with the images achieved through the examination under the electron microscope carried out in those studies where they displayed the formation of a shallow, irregular and deficient hybrid layer.[25,26]

CONCLUSION

Although the self-etch and self -adhesive resin cements are simple in manipulation, their bond strength values are lower than that of total etch technique so they need improvement by manufacturers.

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