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An evaluation of strength of composite resin restorations using different bonding agents- An In-vitro study

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ABSTRACT

In the recent years, the scope of conservative dentistry with emphasis on esthetics has increased by leaps and bounds in enhancing individual personality. Composite resins are important for aesthetic restorations in dentistry, specifically in operative dentistry. But without bonding agents the success of composite restorations is minimized. Researchers are constantly endeavoring to improve the quality of bonding agents. The advent of new bonding systems which are capable of bonding both enamel & dentin has opened new avenues in the field of restorative dentistry. With the market floating with new bonding agents claiming superior bonding properties, this study was undertaken to investigate the degree of bond strength produced by three commercially available bonding agents (Syntac, Scotchbond 1, & Clearfil SE) with composite resin (Esthet-X) taken for the experimental procedure.

KEY WORDS

Bonding agents, Dental adhesive systems,Dentin bond strength, enamel bond strength.

INTRODUCTION

Adhesion of composite to enamel and dentin is inhibited simply because most of the bonding systems do not completely wet the tooth surface. Poor surface wetting ability also allows formation of voids at the tooth-restoration interface and adhesion is further reduced because of local stress concentration at these discontinuities. Surface active hydrophilic adhesion modifiers for promoting strong bond to hard dental tissues, are now entering the dental adhesive art. Ideally bonding system should be hydrophilic to displace water and thereby wet the surface permitting it to penetrate into the surface irregularities to provide good adhesion. However, according to MO Del Nero & de la Macorra J C a perfect seal to dentin is not possible even with current adhesive systems and no correlation was found between tensile bond strength and the ability of any material to seal dentin[1].

The new bonding systems which are capable of bonding both enamel and dentin have contributed substantially in the field of esthetic dentistry. Y Hosoya and A Tominaga compared resin adhesion of five recent bonding systems to primary enamel and concluded that recent bonding systems significantly enhance bonding of resin to enamel[2].

Researchers are constantly striving to improve the longevity & strength of composite restorations with the use of novel bonding agents; however, conflicting results are reported.

MATERIALS AND METHOD

The present invitro study was conducted in the Department of Pedodontics, Dr. Z.A. Dental College & Hospital, AMU, Aligarh in collaboration with the Plastic and Rubber Laboratory, Quality Control Department, Hindustan Aeronautics Limited, Lucknow to investigate the relative bond strength of composite resin -Esthet-X (Dentsply) restorations using three bonding agents *viz.* Scotchbond 1(3M), Syntac (Vivadent) and Clearfil SE(Kuraray). Esthet - X (A product of Dentsply, other than the companies whose bonding agents were used in the study) was used as a composite resin so that no manufacturer can claim that his bonding agent is compatible & coordinated only with his own composite resin product to give better results.

In this study twenty freshly extracted caries free human posterior teeth were selected for the study, which were extracted due to periodontal and orthodontic afflictions. After thoroughly washing the teeth, CI-V cavities were made with airotor using precalibrated straight fissure diamond bur (65 USA size) to standardize cavity depth. A calibrated straight probe was also used to maintain approximately the same depth of all cavities. The samples were divided into one control group (I) and three experimental groups (II, III, & IV) each having 5 samples. The comparison of bond strength was made between control group and experimental groups and within the experimental groups.

Control Group I: The samples were restored with composite after acid etching with 37% phosphoric acid using no bonding agent. Group II: In this group, etching gel & Syntac (Vivadent) were used. Group III: This group was restored with composite using etchant gel & Scotchbond 1 (3M).Group IV: This group was restored with composite using etching gel & Clearfil SE (Kuraray).

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In the experimental groups, samples were first acid etched & then after application of bonding agent & curing, it a thin layer of composite was placed into the cavity and adapted with a clean condenser and cured for 20 seconds. An orthodontic stainless steel wire of 20 gauges was taken. An 'L' shaped bend was prepared. This L-shaped bend was adjusted to the partially restored cavity surfaces and remaining portion of the cavity was filled with composite and condensed to adapt the material to the cavity surfaces. The wire bend was stabilized during condensation. Light curing was done for 20 seconds after stabilizing the wire in place. In the control group, the procedure of restoration of the samples was same except that no bonding agent was used.The bond strength was tested using Instron Machine (Fig.1). First the instrument was calibrated with the standard loads. The block of the sample was tightened in the lower jaw of the machine and the stainless steel wire was tightened in the upper jaw and tension load was subjected to the sample (Figs 2 & 3). The speed of the jaw was kept at 50 mm/minute. When restoration was detached from the cavity, reading was observed from the scale. All the samples were subjected to the machine in the same manner.

The bond strength was obtained by:

$$\text{Strength} = \frac{\text{Force}}{\text{Area}} = \frac{\text{Load} \times 9.8}{\text{Area}}$$

The statistical analysis of the available data was carried out to see the level of significance among different observations (Tables 1and 2.)

RESULTS

The results showed that Clearfil SE has greatest bond strength followed by Scotchbond 1 and Syntac (Fig 4, 5.)

Bond strength is significantly higher when compared within experimental groups(Tables 3 and 4.)

Therefore, following results were drawn from the study:

In the groups studied, bond strength of different bonding agents with composite resin (Esthet-X) was as follows:

- Clearfil SE (IV) > Scotchbond 1 (III) > Syntac (II) > Control (I).
- The bond strength of experimental groups (II III and IV) is significantly higher when compared with control group (I).
- Bond strength between the two groups is significantly higher when compared within experimental groups (Fig.6)

DISCUSSION

There are many bonding agents available in the market. The bonding agents used in present study are single bottle adhesive systems. Single application method simplifies the technique of using these bonding agents without compromising bond strength of the composite to tooth structure. C Prati et al evaluated the resin-dentin interfacial morphology and shear bond strengths of several new dentin bonding systems, and concluded that single-bottle dentin bonding agents showed a resin infiltrated dentin layer (RIDL) morphology and bond strength values similar to multi step dentin bonding agents[3]. In the present study, caries free teeth were selected because bonding to normal dentin showed tensile bond strength significantly higher than that to carious affected dentin[4], however, M Nakajima & H Sano studied bond strength of single bottle dental adhesives with normal and caries affected dentin and concluded that bonding with One Step following etching with 10% phosphoric acid showed lower tensile bond strength to caries affected dentin compared to normal dentin. This difference disappeared when using 32% phosphoric acid, whereas, bond strength to caries affected dentin with Single Bond was always lower than the bond strength to normal dentin regardless of the strength of H_3Po_4[5]. Shear bond strength of a hybrid composite to superficial dentin is greater than shear bond strength of composite to deep dentin when comparison is made using newer adhesive systems[6].

The bonding agents which have good flow can completely wet the cavity surfaces and penetrate into the micro mechanical irregularities. After curing, bonding systems produced a hybrid layer which mechanically bonded to the etched tooth surface and composite, however, acid etching of dentin did not increase bond strength when Prime & Bond 2.1 was used by W W Barkmiler et al [7]. Thoughmarginal adaptation of composite restorations is important to prevent microleakage it could neither be predicted by tensile bond strength nor by the mechanical properties of the composite resin[8]. Me Cabe and JF Rusby S measured the tensile bond strength at various depths, within dentin of four dentin bonding agents (Gluma, Tenure, Scotchbond 2 and Tripton) and concluded that the bond strength values differ significantly among the four products particularly near the surface dentin but trend of decreasing bond strength with increasing depth of dentin was seen common to them all. This suggests that the underlying mechanism of adhesion may be common to all four products despite their differing chemical compositions[9].

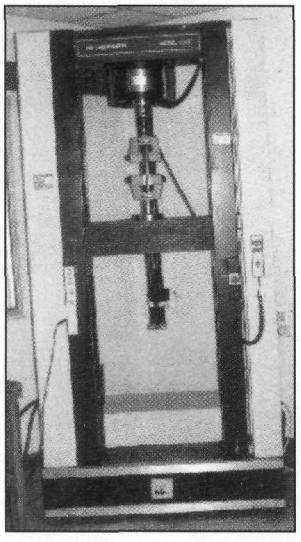


Fig. 1 : Instron machine used in the study.

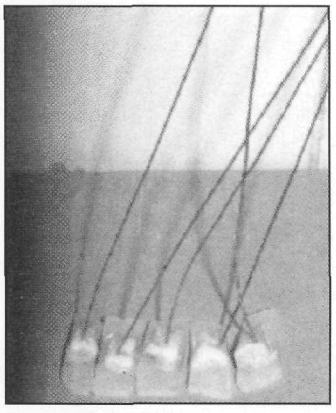


Fig. 2 : Tooth samples before being subjected to the machine (intact samples.)

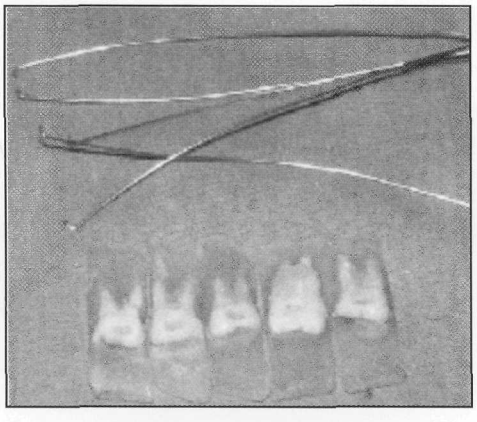


Fig. 3 : Tooth samples after being subjected to the machine (fractured samples.)

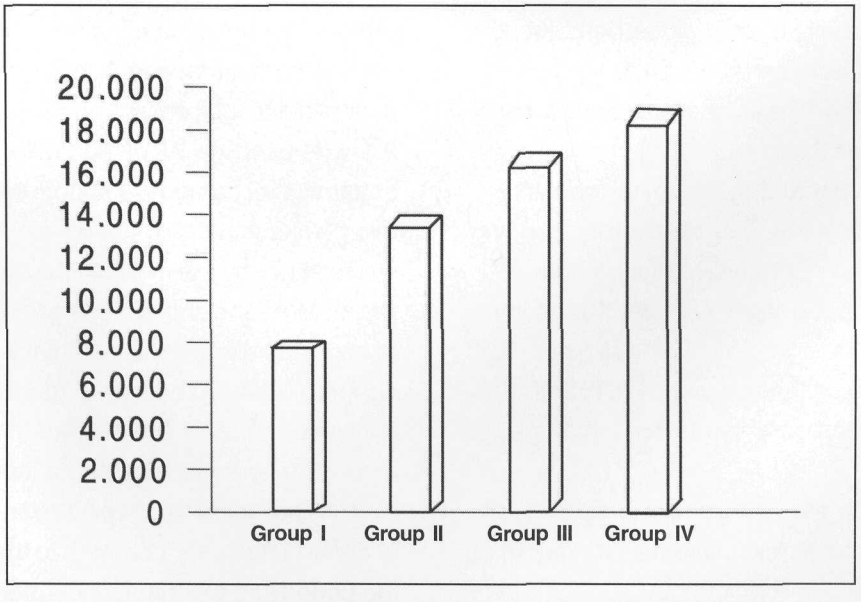


Fig. 4 : Comparison of Means of Bond Strengths of Different Groups.

	Control Group I	Syntac Group II	Scotchbond 1 GroupIII	Clearfil SE Group IV
No. of Samples	5	5	5	5
Mean in Mpa	7.96	14.84	17.15	19.26
SD	$2.75x10^{-2}$	$1.12x10^{-2}$	$2.57x10^{-2}$	$2.56x10^{-3}$
SE	$1.23x10^{-2}$	$4.99x10^{-3}$	$1.15x10^{-2}$	$1.14x10^{-3}$

Table 1 : ANOVA table for the Different Groups.

Source of Variation	D.F.	Sum of square	Mean sum of square	F Ratio
Between	3	361.06	120.35	$F=3.11x10^{-4}$
Within	16	$6.18x10^{-3}$	$3.86x10^{-4}$	P<.001
Total	19	361.07		

Table 2 :Shows F-Values between and within the groups.

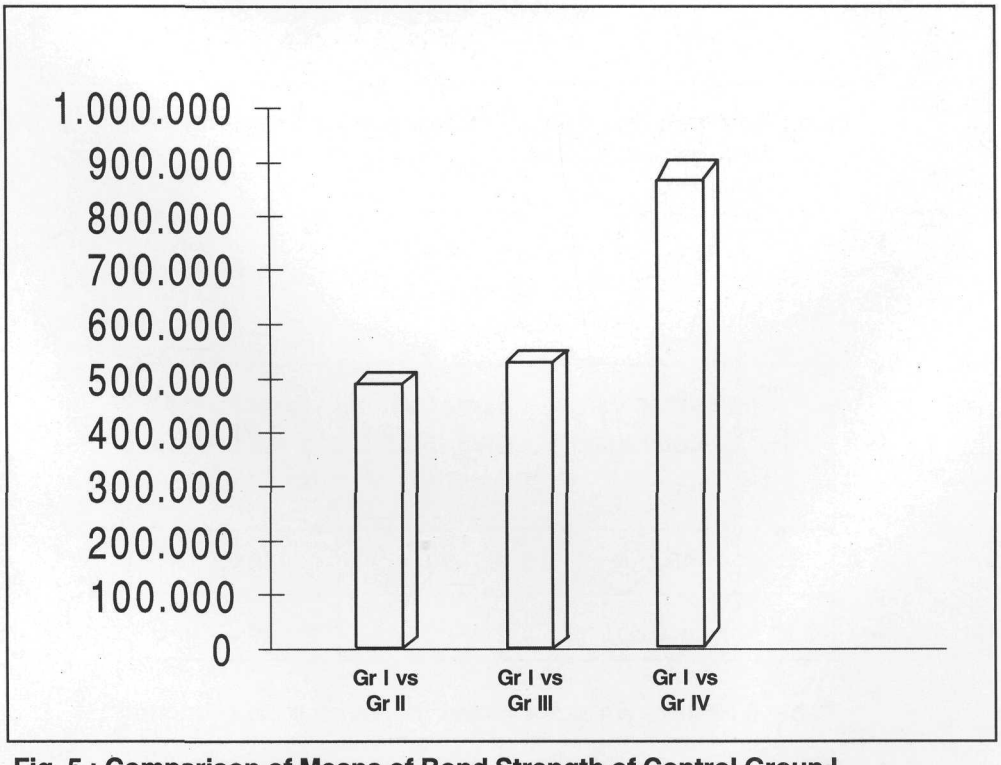


Fig. 5 : Comparison of Means of Bond Strength of Control Group I with Experimental Groups II, III and IV.

	Control Vs. Syntac	Control Vs. Scotchbond 1	Control Vs. Clearfil SE
't'	519.31	546.74	916.34
'p'	p<0.001	p<0.001	p<0.001

Table 3 :Shows p-value of various groups.

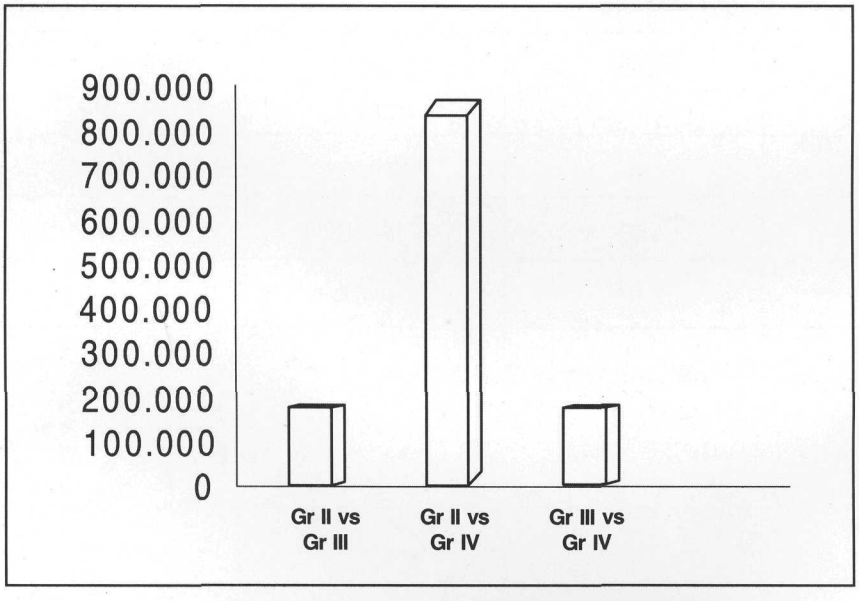


Fig. 6 : Comparison of Bond Strengths within experimental Groups II, III and IV.

	Syntac Vs. Scotchbond 1	Syntac Vs. Clearfil SE	Scotchbond 1 Vs. Clearfil SE
't'	184.54	863.70	182.49
'P'	p<0.001	p<0.001	p<0.001

Table 4 :Shows p-values within the various experimental groups.

EJ Swift et al evaluated shear bond strength of six bonding agents and concluded that mean bond strength ranged from 14.2 M Pa of Syntac (slightly lower than the value found in our study -14.84 M Pa) to 27.8 M Pa of Single Bond[10]. A I Abdalla evaluated microtensile & tensile bond strength of five single bottle adhesives (Scotchbond 1,Syntac SC, One Step, Prime & Bond 2.1 and Clearfil SE) and concluded that Clearfii SE showed highest bond strength in both tensile & microtensile modes.This was in agreement with our study. One Step showed least bond strength in tensile mode while Prime & Bond 2.1 showed least bond strength in microtensile mode[11].

Decreased bond strength in control group was observed because after acid etching,composite was filled in the cavity without bonding agent, it did not wet the cavity surfaces and also did not penetrate into the micro mechanical irregularities. This was because composite resin was highly viscous than bonding agents and did not produce hybrid layer, thus resulting in a weak adhesive joint.

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