Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2016;5:1:94-99.

Comparative Evaluation of Tensile Bond Strength of Newer Generation Bonding Agents: An In Vitro Study

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ABSTRACT

Background: Aim: To evaluate and compare tensile bond strength of sixth generation, seventh generation and eighth generation dentin bonding agents.

Method and Materials: Forty five freshly extracted caries free, unrestored human molars were selected. The occlusal surfaces were ground until flat and then they were divided into three groups. In Group A, sixth generation dentin bonding agent was applied onto the flat surface, likewise we applied, seventh generation and eighth generation in Group B and Group C respectively. All the samples were then restored with composite and evaluated for tensile bond strength test using universal testing machine.

Statistical analysis: The data for this study was analysed using the ANOVA & Bonferroni statistical test.

Results: Eighth generation dentin bonding agent (Group C) showed significantly higher value as compared to seventh generation (Group B) and sixth generation (Group A) dentin bonding agents.

Conclusion: The mean tensile bond strength score was found to be maximum in eighth generation dentin bonding agent (Group C) followed by sixth generation (Group A) and was least in seventh generation (Group B) dentin bonding agent.

Keywords: Sixth, Seventh and Eighth generation bonding agents, Tensile bond strength.

INTRODUCTION

The introduction of tooth-colored composite represented a leap forward in the development of adhesive system. Adhesion to dental tissue is a fundamental requirement prior to the insertion of tooth colored restorative material[1]. Given the enormity of the number of commercial products available in the field of adhesion, the evaluation of bond durability is important, as the stability of the bond between the restoration and tooth substrate may be related to long-term clinical success of tooth colored restorations.[2] A variety of adhesive systems are continuously being developed in order to produce good adhesion to dental substrates.[3] During the past many years, extensive research efforts have been directed towards the development of dentin bonding agents.[4]

To better describe these adhesive or dentin bonding agents the term "generations" was established .[5] Most common bonding agents used today belong to sixth, seventh or more recent eighth generation. The sixth generation bonding agents or self-etch adhesives combine acid conditioning with the priming and bonding procedure. The rationale

Received: June. 16, 2015: **Accepted:** Aug. 1, 2015
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pISSN 2278-0076
eISSN 2321-9270

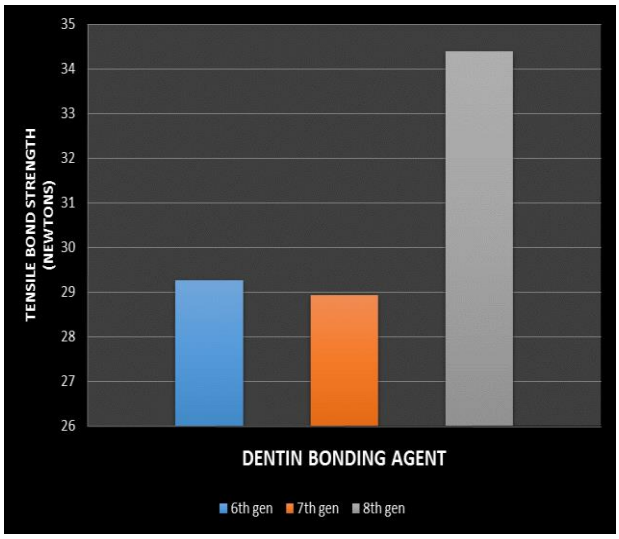

Fig 1: Graphical representation of mean tensile bond strength among all the groups.

Fig 2: Preparation of occlusal surface.

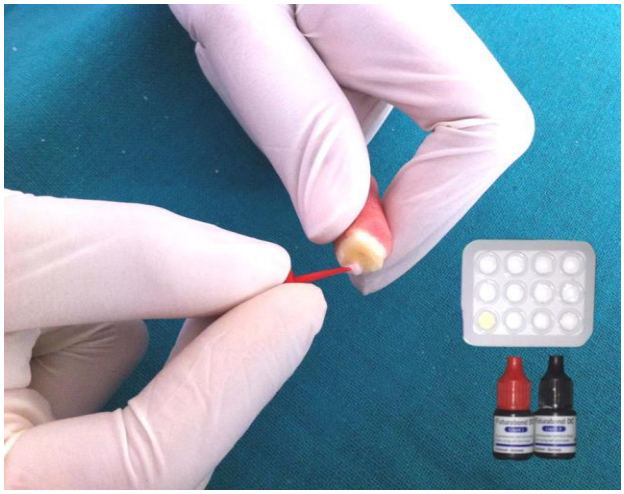

Fig 3: Application of Dentin Bonding Agent.

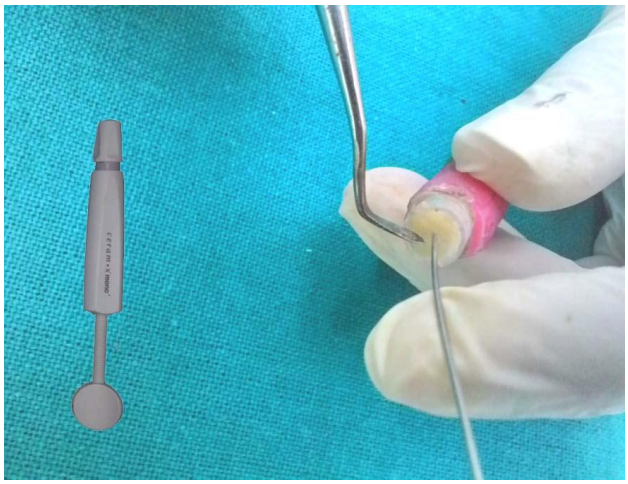

Fig 4: Restoration of Samples Using Ceram X Mono.

Fig 5: Samples being light cured.

Table 1: Mean values in various groups.

Groups	Mean	Std. Dev	Median	Std. Error of Mean
A 6th generation	29.26	1.8310	29.000	0.4727
B 7th generation	28.92	1.2133	29.470	0.3133
C 8th generation	34.39	1.6125	34.180	0.4163

behind this system is to superficially demineralize dentin and simultaneously penetrate it with the monomers.[6]

The seventh generation primer–adhesive combination demineralizes the smear layer and the top layer of the underlying dentin surface. They also

infiltrate collagen fibers and copolymerize, minimizing voids and potential leakage. Because the etched surface is not rinsed, the demineralized smear layer is incorporated into the hybrid layer.

Table 2: Distribution of variance between the groups using anova test.

	Sum of Squares	df	Mean Square	F	Sig
Between Groups	282.038	2	141.019	56.982	0.000
Within groups	103.943	42	2.475		
Total	385.981	44			

Table 3: Intergroup Comparison Of Tensile Bond Strength Among Various Groups By Bonferroni Test.

(I) grp	(J) grp	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
6th generation	7	.3447	.5744	1.000	-1.088	1.777
	8	-5.1300*	.5744	.000	-6.562	-3.698
7th generation	8	-5.4747*	.5744	.000	-6.907	-4.042

The more recent nano adhesives or the eighth generation adhesives have been introduced in the market. These nano adhesives contains nano sized filler particles. These nano filler particles prevent agglomeration thus producing high dentin bond strength, longer shelf life, durable marginal seal and release of fluorides.[7] The efficacy of dentin-bonding agents is mainly evaluated by tensile and/or shear bond strength measurements.[8] However, tensile bond strength test has been accepted as a versatile and reliable in vitro test to quantify the bonding effectiveness and stability of adhesive biomaterials bonded to tooth structures. A good accuracy is achieved owing to the availability of more surface area for bonding and testing as a whole and determination of bond strength in relation to surface area tested. Over such a surface, stress distribution is expected to be uniform, thus enabling the test measurements to truly express the interfacial bond strength.[9]

The aim of the study was to compare In-vitro tensile bond strength of sixth generation (FL Bond II, Shofu INC, Kyoto, Japan), seventh generation (Xeno V, Dentsply, Germany) and eighth generation ((Futurabond DC, Voco, Germany) dentin bonding agents.

MATERIALS AND METHODS

A total of forty five extracted caries free, unrestored human molars extracted either due to periodontal pathology or traumatic injuries were selected and stored in distilled water. The teeth were to be used within 3 months of collection as per recommendations of Occupational Safety and Health Administration (OSHA).The teeth were divided into the following three groups and color coded for easy demarcation.

In Group A, sixth generation bonding agent (FL Bond II, Shofu INC, Kyoto, Japan) was color applied and it was color coded as yellow. In Group B, seventh generation bonding agent (Xeno V, Dentsply, Germany) was applied and it was color coded as blue and in Group C: eighth generation bonding agent, Futurabond DC, Voco, Germany), was applied which was color coded as orange.

Sample preparation:

The occlusal surfaces of these teeth were ground using a water cooled diamond disc mounted on an air motor hand piece until all occlusal enamel was removed (FIGURE 2). The teeth were individually embedded in acrylic resin blocks.

Then the adhesives were applied according to the manufacturer's instructions (FIGURE 3). After applying bonding agents and curing, a poly vinyl hollow mould was used. This hollow mould was held on adhesive-treated surface of specimens and then composite resin (Ceram X, Dentsply, Germany) of thickness 2 mm was placed inside the mould and condensed. A twisted 26-gauge ligature wire with a loop was placed inside the 2 mm of composite resin, held straight and light cured for 40s. Another 3 mm

thickness of composite resin was placed and light cured incrementally (FIGURE 4-5). Following complete curing, the mould was split and removed leaving the 5 mm of cured resin with twisted wire bonded on to surface of dentin.

A few specimens that showed a spontaneous bond failure during removal of the mould were discarded. However new specimens were added after analyzing the bond failure so as to maintain the required sample size. The teeth were then incubated at 37 ^{0}C for 24 hours to simulate the oral conditions. The collected samples were subjected to tensile bond strength test. The tensile bond strength tests were measured using the Universal Testing Machine (INSTRON), at a cross head speed of 1 mm / minute (FIGURE-6) The data for this study was analysed using the ANOVA & Bonferroni statistical test to evaluate and compare the tensile bond strength of newer generation bonding agents.

RESULTS

Table I shows that mean tensile bond strength value in sixth generation was 29.26 N, 28.92 N in and 34.3 N in sixth generation, seventh generation and eighth generation respectively. The highest strength was seen in eighth generation bonding agent (Group C) followed by sixth generation bonding agent (Group A) and least in the seventh generation agent (Group B)

Table II shows the Analysis of variance test which compared the mean scores of all the three groups. In this analysis the difference between the mean tensile bond strength values of Group A, Group B and Group C were compared and was found to be highly significant at $p<0.000$.

Table III shows intergroup comparison of tensile bond strength using Bonferroni test, it was seen that all the intergroup comparisons were highly significant except between sixth generation bonding agent (Group A) and seventh generation bonding agent (Group B) with a p value taken significant at 0. 05.

DISCUSSION

It was seen that tensile bond strength value was highest in eighth generation bonding agent (Group C), followed by sixth generation bonding agent (Group A) and least in seventh generation bonding agent (Group B). These findings were in accordance to the study done by Joseph P, Yadav C, Satheesh K, Rahna R (2013).[7]

The 8th generation dentin adhesives contain nano fillers. Filler particles include micro fillers, also called nano fillers and sub-micron glass.[7] After light-curing, these nano filler particles bonds with the resin matrix of the adhesive and thereby act as a strengthening element for the demineralized dentin, replacing the solubilized apatite filler crystallites to some extent. As a result, this structural condition improves the mechanical properties of hybrid layer of eighth generation dentin bonding agent. Thus filled bonding agents tend to produce higher *in vitro* bond.[10]

Another possible reason is that the eighth generation dentin bonding agent (Futurabond DC) has lower pH value of 1.4 in comparison to higher pH value of 1.8 and 2.4 of seventh and sixth generation dentin bonding agents respectively. Because of lower pH a complete removal of smear layer is achieved,[11] hence better bond strength is obtained.

The sixth generation bonding agent (FL Bond II) used in this study contains HEMA while the seventh generation bonding agents used in this study (Xeno V) is HEMA free. This HEMA is known to prevent phase separation in addition to solubilizing insoluble monomers in water, improves hydrogen-bonded interaction with collagen fibers exposed by acid-etching thus, enhancing the bonding of resin to the collagen fiber.[2]

Lower bond strengths of seventh generation bonding agents or all-in-one adhesives (Xeno V) are usually explained as a consequence of increased hydrophilicity due to joining primer and adhesive in one bottle.[12] The increased concentration of hydrophilic resin monomers in simplified etch-and-rinse adhesives may preclude the complete water removal after rinsing off the phosphoric acid and drying. Remnants of water may remain “trapped” in the adhesive layer. Studies have shown that water may exist in the adhesive layer as free, within the collagen matrix, or bound, if it forms hydrogen bonds with hydrophilic resin monomers.[13]In areas where water remains, polymerization may be incomplete. Also, these

areas represent porous regions which may facilitate hydrolytic degradation of adhesive interface.[14] The comparison between sixth generation bonding agent (Group A) and seventh generation bonding agent (Group B) revealed that difference in the mean tensile bond strength value between the two group is statistically insignificant . However the mean value of sixth generation is slightly higher than seventh generation dentin bonding agent, which was similar to the study done by Viresh Chopra, Himanshu Sharma, and S Datta Prasad (2013).[15]

So according to the present study, 8th generation dentin bonding agent presents a better tensile bond strength, when compared to 6th and 7th generation dentin bonding agents. However, we recommend further studies to authenticate these results.

CONCLUSION

Based on the results it was concluded that:

1. The mean values of tensile bond strength was found to be highest in eighth generation dentin bonding agents followed by sixth generation and lowest value in seventh generation dentin bonding agents.

2. When inter comparison was done, eighth generation dentin bonding agents showed significantly higher score of tensile bond strength when compared to sixth and seventh generation dentin bonding agents.

3. In inter comparison, tensile bond strength score of sixth and seventh generation dentin bonding agents was found to be non-significant.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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