ORIGINAL RESEARCH

To Compare and Evaluate the Shear Bond Strength of Sixth- and Seventh-generation Bonding Agents

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Abstract

Aim: To compare and evaluate the shear bond strength of sixth and seventh-generation dentin bonding agents.

Materials and methods: Around 75 extracted permanent mandibular premolars were selected and assigned into two groups. The samples were cleaned, cavities were prepared, and the bonding agent was applied and stored in distilled water for 24 hours. Shear bond strength testing was done using a universal testing machine at the crosshead speed of 1 mm/minute. Data were analyzed statistically by one-way analysis of variance (ANOVA) and paired test.

Results: The greatest mean shear bond strength to dentin was exhibited by the sixth-generation dentin bonding agent due to the solvent present, which has a low concentration and low hydrophilicity than the seventh-generation.

Conclusion: Sixth-generation adhesives showed significantly higher mean shear bond strength to dentin than seventh-generation adhesives.

Clinical significance: Bond strength values are gross assessing tools for evaluating the efficacy of restorative bonding materials to dentin. And as the shear bond strength is less technique sensitive to perform, it will highlight the strength at the bonded interface.

Keywords: Dentin bonding agents, Shear bond strength, Universal testing machine.

International Journal of Clinical Pediatric Dentistry (2022): 10.5005/jp-journals-10005-2422

Introduction

Evaluate and compare the shear bond strength of different generations of bonding agents, such as sixth and seventh-generation bonding agents, which are self-adhesive with hydrophobic and hydrophilic components. But has the disadvantage of the formation of drops in between the adhesive layers.[1]

Materials and Methods

The study was conducted at Rajasthan Dental College & Hospital, Jaipur, Rajasthan, in which recently extracted 50 human extracted mandibular premolars specimens were selected (Fig. 1).

A total of 50 single-rooted freshly extracted specimens were cleaned and stored in saline solution till evaluated.[2] Polishing of teeth was done using the standard protocol by pumice slurry and water. And the teeth were sectioned coronally and embedded in acrylic resin in a cylindrical mold of metal with dimensions 2 × 2 breadth (Fig. 2).

These teeth were attached by lying, and the buccal surface of each tooth was reduced by 1.5 mm using #245 carbide bur using appropriate cooling under a high-speed handpiece to expose flat enamel or dentin surface (Fig. 3).[3,4] The prepared samples were randomly divided into two groups,[5] with 25 specimens in each group, namely:

Group I: Sixth-generation dentin bonding agent (One Coat, Coltene, Whaledent); group II: seventh-generation dentin bonding agent (One Coat 7.0, Coltene, Whaledent).

The tooth surface will be rinsed, cleaned with pumice,[6] and blotted dry. The bonding agent was applied with microbrushes and cured under strict manufacturer instructions (Figs 4 and 5). The placement of composite resin was done in parts and cured after removing them from molds. All specimens were stored in distilled water for 24 hours[7,8] prior to shear bond testing.

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How to cite this article: Adyanthaya BR, Gazal S, Mathur M, *et al.* To Compare and Evaluate the Shear Bond Strength of Sixth- and Seventh-generation Bonding Agents. Int J Clin Pediatr Dent 2022;15(5):525–528.

Source of support: Nil

Conflict of interest: None

Specimens were mounted on the universal testing machine,[9,10] as this is considered a specific instrument for checking microtensile strength, and force was applied by the universal testing machine at a crosshead speed of 1 mm/minute in a compressive mode at the adhesive-dentin interface (Fig. 6). Samples were positioned horizontally so that its blade was held at 90° at the restorative-dentin interface. Every specimen was loaded up to its final elastic limit. The shear force required to break the bond of the specimens was recorded.

Statistical Analysis

The mean value of shear strength, standard deviation (SD), and all descriptive statistics were calculated and tabulated (Tables 1 and 2). One-way ANOVA was used to compare the values between the groups. The difference between the individual groups was checked by paired sample test (Table 3).

Statistics value in between values of mean, SD, and standard error of sixth and seventh-generation dentin bonding agents is shown in Table 2, which shows a significance of 0.000 (Fig. 7).

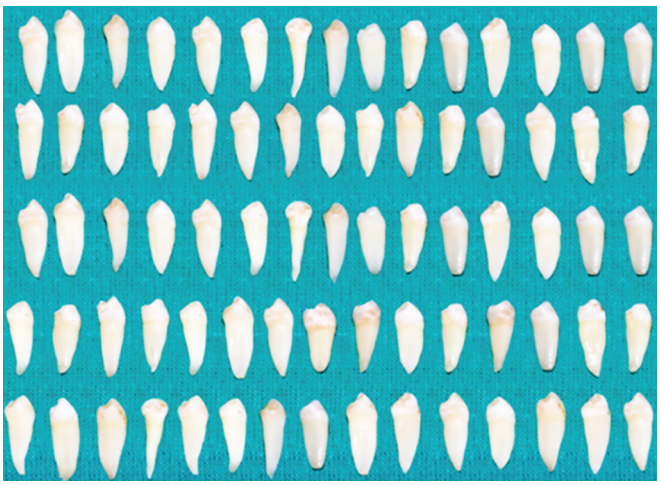

Fig. 1: Extracted mandibular teeth

Fig. 2: Sectioning of tooth

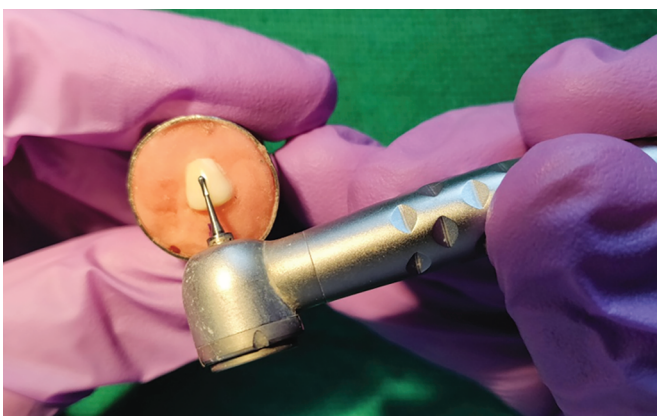

Fig. 3: Preparation of cavity

Fig. 4: Application of sixth-generation bonding agent

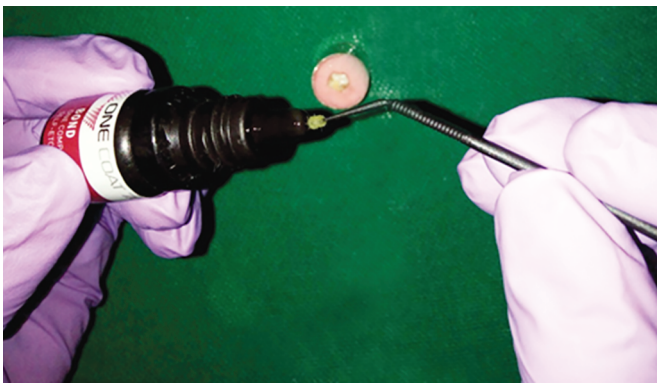

Fig. 5: Application of seventh-generation bonding agent

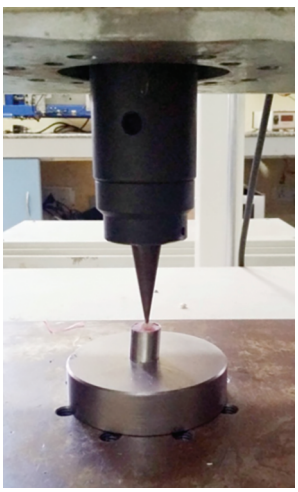

Fig. 6: Universal testing machine

Discussion

Advanced adhesive systems have simplified application protocol with a reduction in the number of clinical steps for ease of use.[11] With the use of bonded restorations and its clinical use of composites has increased considerably over the few years due to increased demands by patients, new, improved formulations, and simplification of bonding procedures[12] before the application of bonding agents etching of tooth is to be done which can show different patterns such as type I etching pattern where prism core material was removed leaving the prism peripheries relatively intact. In the second type II etching pattern, the reverse pattern was observed. The peripheral regions of prisms were removed, leaving prism cores remaining relatively unaffected. In the type III etching pattern, there was a more random pattern,[13] the bonding between the tooth and restorative material or resins involves some phases, which are as follows-the first phase includes the removal of the ions such as calcium phosphate, by which microporosities are created in both enamel and dentin surfaces.[11]

The second phase is the hybridization phase, which means the invagination of resin inside the surface microporosities, which results in micromechanical interlocking.[14] Multiple steps in bonding systems were more complicated, time-taking, and technique sensitive, so the evolution of today's universal adhesive systems is there with an improved bond to enamel, dentin, amalgam, metal, and porcelain.[11] In the study shear bond was seen, which is a simple procedure for testing the adhesion of dental adhesives; this test can be done with a universal testing machine,[15] and that can also be calculated by using finite element stress analysis.[16]

Table 1: Readings of shear bond strength of sixth- and seventh-generation dentin bonding agents

Sample no.	*Sixth-generation dentin bonding agent*	*Seventh-generation dentin bonding agent*
1	700	804
2	900	455
3	500	581
4	800	380
5	931	496
6	600	555
7	500	380
8	700	580
9	650	800
10	900	360
11	800	572
12	600	360
13	500	450
14	750	380
15	600	496
16	700	455
17	750	581
18	650	567
19	920	708
20	550	804
21	650	455
22	700	398
23	800	466
24	600	380
25	900	804

In the study conducted by Gangurde et al. in 2014 conclusion was made that the dentin bonding agent (Excite) showed the highest shear bond strength as compared to Single Bond and Prime & Bond NT[17] and another study which was done by Chopra et al. in 2009, compared the tensile bond strength of UniFil Bond vs iBond and concluded that UniFil Bond (multibottle system-sixth-generation type I) in which UniFil performed better than iBond (single bottle system-seventh-generation). This can be due to minimized polymerization contraction. And the configuration factor was found to be 0.33, with low interfacial stresses.[18] And the study conducted by Sohrabi et al. showed an increase in microtensile strength bond strength of two-step AdheSe than Xeno III 15. A study conducted by Toledano et al. compared the bond strength [microtensile bond strength (MTBS)] of five adhesive systems (Single Bond, Prime and Bond NT, Prime & Bond XP) and two self-etching agents (Clearfil SE Bond and Etch and Prime 3.0) among them, the highest MTBS values were obtained for Clearfil SE Bond and Prime & Bond XP.[19] There are certain studies contradicting these results stating that single bottle system showed better performance than two-step self-etch system. The evolution of the self-etching priming systems has led to an improvement in bond strengths also.[14,20,21] Yaseen, Subba Reddy VV showed the lowest shear bond strength on deciduous teeth with a sixth-generation bonding agent and the highest with the seventh-generation on permanent teeth.[22] And also, the use

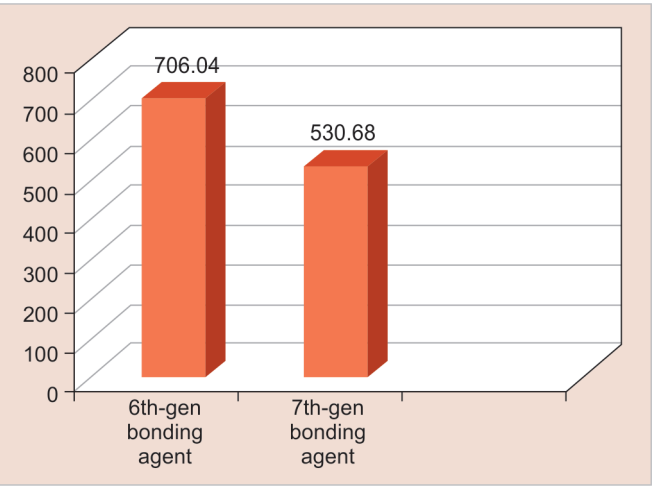

Fig. 7: Graph illustrating that there was a significant difference in sixth- and seventh-generation dentin bonding agents

Table 2: Comparison between mean and SD of sixth- and seventh-generation dentin bonding agents

	N	*Mean*	*SD*	*Standard error*
Sixth-generation dentin bonding agent	25	706.04	136.298	27.260
Seventh-generation dentin bonding agent	25	530.68	149.467	29.893
Total	50	635.39	200.324	23.131

Table 3: Paired samples test

Paired differences							
		Standard error mean	*Difference*				
Mean	*SD*		*Lower*	*Upper*	*t*	*Difference*	*Significant (two-tailed)*
175.360	195.822	39.164	94.529	256.191	4.478	24	0.000

of both the total etching -single bottle system and the self-etching adhesive system proved to be equally effective in providing bonds in primary dentin.[11,23] Nair et al. in 2014 showed higher shear bond strength with seventh-generation (Adper Easy One) did comparison with sixth-generation (Adper SE Plus) bonding agents.[24] Chopra et al. in 2009 observed that conventional bonding agents performed better than single-bottle dentin adhesives.[18] In a study by R Van Noort et al. in 1989 observed that uniformity of tensile and shear stress at the interface between tooth structure and composite resin had not been achieved.[16] Bond strength testing with dentin depends on various factors, but the use of a self-etching system does not dependent on the smear layer thickness.[25,26] Factors are type, age of teeth, degree of dentin mineralization, dentin surface being bonded, type of bond strength test (shear/tensile), storage media, relative environmental humidity in substrates, complex nature of testing procedures, the sensitivity of manipulation of these systems and composite restorative material.[27] There are other agents available nowadays, such as eighth-generation dentin bonding agents, which provide better bond strength and prevent agglomeration, which is still in research.[28]

Conclusion

Under limitations of this study, it was observed that sixth-generation dentin bonding agents have higher mean shear bond strength to dentin than seventh-generation adhesives, probably because of low hydrophilicity and limited etching of underlying dentin.[29] There was a significant difference in shear bond strength when compared with all the different self-etching adhesives used in the study.

Clinical Significance

Under the clinical trials on specimens, it has been observed that to check or evaluate the bonding of restorative materials to dentin, testing of shear bond strength at the interface is a less technique-sensitive assessing tool.

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