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RESEARCH ARTICLE

COMPARATIVE EVALUATION OF THE SHEAR BOND STRENGTH OF SIXTH AND SEVENTH GENERATION BONDING AGENTS: AN IN VITRO STUDY

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ABSTRACT

Aim: To compare the shear bond strength of sixth generation and eighth generation bonding agents to dentin. **Materials and methods:** Flat surface of dentin were exposed after reducing the enamel surfaces of forty human molar teeth and were divided into two groups (n=20), which were then bonded using Sixth-generation bonding agent, Prelude Dental Adhesive (Danville) and Seventh-generation bonding agent, Prelude One (Danville) which is a one bottle adhesive. Group I- Prelude Dental Adhesive system which is two bottle system (n=20) was applied as per manufacturer's instructions. Group II - Prelude One which is a one bottle adhesive system (n=20) was also applied as per manufacturer's instructions. Following this, composite cylinders were built up using a Teflon mould (3x2mm) on these prepared dentinal surfaces. Samples were stored in distilled water for 24 hours and tested for shear bond strength with universal testing machine. Shear force was applied perpendicular to the long axis of composite cylinder at adhesive-tooth interface until debonding occurred. The data obtained was tabulated and analyzed statistically using analysis of variance (ANOVA) test. **Results:** There was a significant difference in the shear bond strength of both the adhesives tested ($P < 0.05$). The seventh-generation adhesives showed significantly higher shear bond strength to dentin compared to sixth-generation adhesives. **Conclusion:** Among self-etch systems, single-step bonding agents are superior to two-step systems.

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INTRODUCTION

From their initial development till now adhesive bonding composite resins has revolutionized restorative dentistry. The adhesive systems have evolved not only with changes in their chemistry, mechanism but also number of steps, application techniques, and their clinical effectiveness (Toledano et al., 2001). Ideal property of any dental adhesive should be sufficient bonding strength and no micro leakage. Though the multiple step bonding systems like 4th and 5th generation bonding systems have good strength its use is complex and time consuming, and hence demanded simpler solutions (Tay et al., 2000). First steps towards the solution was 6th-generation bonding agents which are self-etching, which means that they do not need phosphoric acid to demineralize tooth structure. They contain a self-etching primer that demineralizes and primes the tooth structure simultaneously. They also utilize a hydrophobic adhesive that bonds more readily to composites. One-Step self-etching adhesives are becoming increasingly more popular due to convenience and improved bonding mechanism (Carvalho et al., 2005). Currently, the "7th generation self-etch systems" combine an etchant, primer, and adhesive in one container compared to

total-etch or etch and rinse systems, whereby separate etchant, primer, and adhesive monomers are utilized. The 7th-generation dentin bonding agents are called as self-etching or all in one adhesive which required no mixing. Thus, they are time-saving (Nair et al., 2014). The self-etching adhesives not only involve a less technique-sensitive procedure, since the etch-and-rinse phase is omitted, which may cause collapse of vulnerable demineralized collagen network after acid etching but are also less time consuming, they also simultaneously cause demineralization and resin infiltration of hybrid layer. There are few studies that have compared the shear bond strength of sixth and seventh generation bonding agent and the bonding agents used in this study have not been compared in any other study. The present in-vitro study will be investigating and comparing the shear bond strength of Prelude Dental Adhesive (sixth) and Prelude One- One bottle adhesive (seventh) generation bonding systems.

MATERIALS AND METHODS

Forty freshly extracted, human molars that were indicated for extraction were selected for this study. The collected teeth were cleaned thoroughly. The root portion of teeth were sheared off, and only the coronal portion was used which was embedded in a block of dental resin made with the help of a mould having dimensions 1.5 × 1.5 cm and a height of 2 cm.

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Fig. 1. (A) Flat dentin discs, (B and C) Discs embedded in blocks of dental resin.

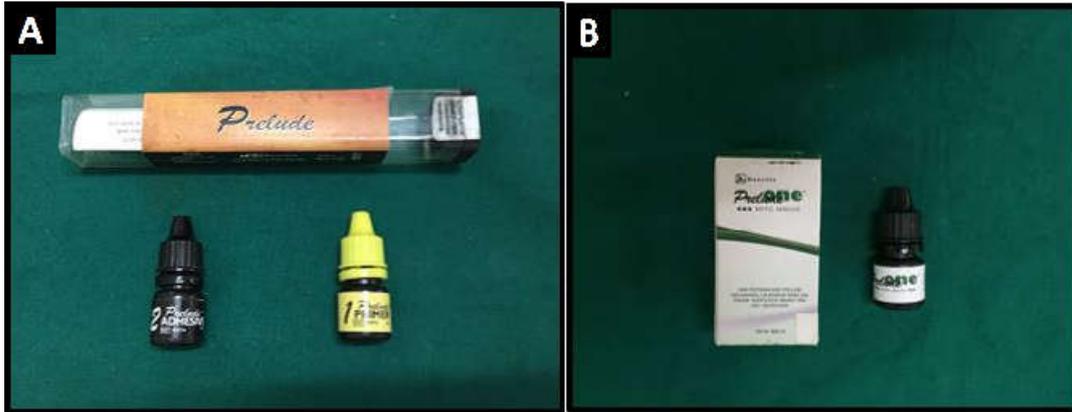


Fig. 2. (A) Sixth generation bonding agent, Prelude One, (B) Seventh generation bonding agent, Prelude One

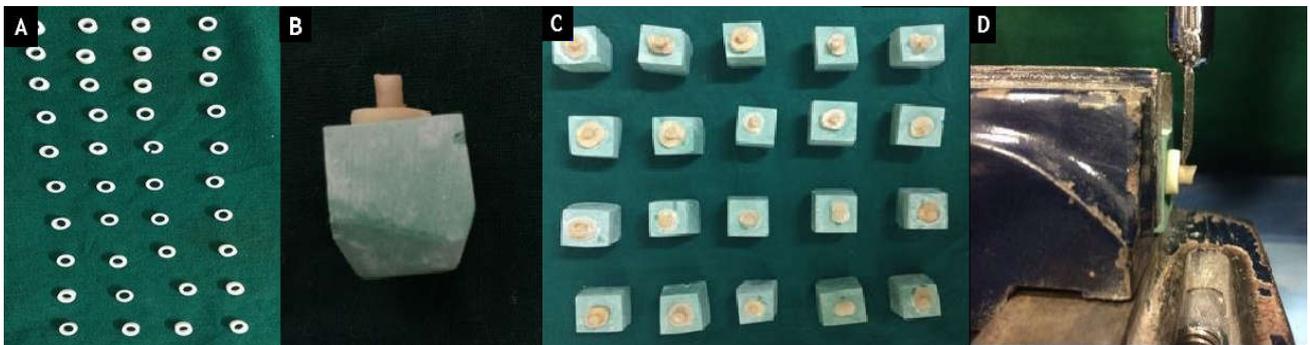


Fig. 3. (A) Teflon mould for preparing composite cylinders, (B and C) Composite cylinders luted using bonding agents, (D) perpendicular force applied using universal testing machine

With the help of a high-speed handpiece using #245 carbide (Mani Inc. Japan) bur under constant water spray the occlusal surface of each tooth was reduced in order to expose flat surface of dentin. These discs were then randomly divided into two experimental group, with each group having 20 samples.

Group A: (n=20) Sixth-generation bonding agent, Prelude One (Danville materials)

Each disc was prepared by applying a layer of 6th-generation primer and was scrubbed and air dried with three way. Then the adhesive was applied and air dried for 5 seconds until film did not appear shiny. Light curing was carried out for 10 seconds.

Group B: (n=20) Seventh-generation bonding agent, Prelude One (Danville materials)

Each disc was prepared by applying a layer of 7th gen. bonding agent was scrubbed for 20 sec using disposable brush the layer

was air dried for 10 seconds until the film appeared glossy. Light curing was carried out for 10 seconds.

Samples were stored in distilled water for 24 hours. Composite cylinders were prepared using teflon moulds and these were then bonded to the flat dentin surface using the bonding agents. Samples were tested for shear bond strength with universal testing machine. These samples were mounted on the universal testing machine (Unitek, 9450 PC, FIE, INDIA). The shearing blade was kept perpendicular to the bonded composite cylinder at composite-dentin interface. The force applied by the machine on each specimen was kept at a crosshead speed of 1 mm/min in a compression mode using a blade. Each sample was loaded until debonding took place. The shear force value required to de-bond the specimen was recorded. Debonding stress in megapascal was then calculated by the ratio of maximum load in Newton to the surface area of prepared resin cylinder ($\text{MPa} = \text{N}/\text{mm}^2$). The data so obtained were tabulated and analyzed statistically using independent-samples t-test and analysis of variance (ANOVA) test.

RESULTS

There was a significant difference in the shear bond strength of both the adhesives tested ($P < 0.05$). The seventh-generation adhesives showed significantly higher shear bond strength to dentin compared to sixth-generation adhesives.

Table 1. Shear bond strength(SBS) values for Sixth and Seventh generation bonding agents

SR NO	Group A		Group B	
	Max load	SBS	Max load	SBS
1	91.3	7.26	39.25	3.12
2	77.55	6.61	80.05	6.36
3	68.7	5.46	86.35	6.87
4	32.05	2.54	48.1	3.82
5	81.95	6.51	40.55	3.22
6	70.45	5.6	58.3	4.64
7	65.23	5.31	37.35	2.97
8	74.7	5.94	45.2	3.59
9	66.9	5.32	15.4	1.22
10	96.75	7.69	51.7	4.11
11	61.82	4.91	36.33	2.88
12	66.7	5.3	82.3	6.54
13	50.2	3.2	84.5	6.72
14	82.34	6.8	50.66	4.02
15	46.66	5.14	39.78	3.11
16	63.45	5.04	53.9	3.16
17	90.67	7.21	32.11	2.55
18	77.77	6.72	41.68	3.31
19	58.9	4.68	45.22	3.59
20	62.25	4.95	54.31	4.32

Table 2. Mean and Standard deviation of tested samples for both the groups

	Mean	Standard Deviation	t-value	P-value
Group A	5.6	1.2	3.583	0.001
Group B	4	1.5	3.583	0.001

DISCUSSION

Dr. Gunnar Ryge of Marquette University and Professor Philip, discussed the theoretical possibility of bonding resins to dentin, 5 decades ago, which further introduced the concept of bonding-restorative materials to tooth structures (Leinfelder *et al.*, 2003). A higher placement complexity and technique sensitivity are the major drawbacks of the adhesive techniques (Van Meerbeek *et al.*, 2003). In order to achieve good marginal adaptation and to prevent microleakage, recurrent caries, and pulpal irritation, the integrity of bond between dentin and resin adhesive systems plays an important role in clinical dentistry. Technological advancements of dentin adhesives have evolved into two trends: total acid-etching techniques (5th-generation dentin bonding agents) and self-etching primer technique (6th and 7th-generation dentin bonding agents) (Kallanos *et al.*, 2005). The use of all-in-one adhesives combines acid, primer, and resin in one bottle and eliminates separate etching, rinsing, and mixing. This has been one of the biggest areas of development in dentin bonding systems (Sofan *et al.*, 2017). Morphological differences that exist between the bonds of total-etch and self-etch systems. The thickness of the hybrid layer differs for the total-etch and self-etch systems. For the self-etch bond systems the hybrid layer formed is more homogenous, that better disseminates the stress in the adhesive (Uekusa *et al.*, 2006). Dentin bond strength is proportionate to the resin tags interlocking with collagen fibers as well as the quality of the hybrid layer. The sixth-generation bonding systems showed sufficient bond to conditioned dentin while the bond with enamel was less effective. This may be due to the resin tags formed with the etch-and-rinse adhesives which are much longer than those

found in self-etching adhesives but both systems form a continuous and uniform hybrid layer (in terms of thickness) (Uekusa *et al.*, 2006). The shear bond strength of the bonding agents used in the present study has not been compared in any other study. A study conducted by Nair *et al.*, compared the bonding efficacy of sixth and seventh generation bonding agents. The seventh-generation adhesives showed significantly higher shear bond strength to dentin compared to sixth generation. The highest value of shear bond strength was obtained from Adper Easy One system, while Adper SE Plus gave the lowest shear bond strength values (Nair *et al.*, 2014). The results of their study are in accordance with the results of our study. The findings of a study conducted by Yaseen *et al.* showed that, Clearfil S3 (seventh-generation) showed higher shear bond strength than Contax (sixth-generation) dentin bonding systems. These results are also in accordance with the results of our study. They also found that permanent teeth showed higher shear bond strength than primary teeth, irrespective of bonding system (Yaseen and Subba Reddy, 2009).

Conclusion

Single-step bonding agents are superior to two-step systems, among self-etch systems. Also, in the self-etch systems, depth of dentin demineralization and resin monomer penetration is equal and occurs simultaneously.

Conflict of interest: There was no conflict of interest among the authors.

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