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A Comparative Evaluation of the Shear Bond Strength of Three Different Fifth Generation Dentin Bonding Agents: An in vitro Study

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ABSTRACT

Purpose: To compare and evaluate the shear bond strength of three different fifth generation dentin bonding agents used with composite resin.

Materials and methods: Forty-five freshly extracted human permanent molars were used and the specimens were divided into three test groups (N = 15) namely:

Group A = Excite

Group B = Optibond solo plus

Group C = Prime and Bond NT.

The occlusal surfaces of the specimens were ground to expose the superficial dentin and mounted in self cure acrylic resin. The surface was etched with 37% phosphoric acid gel and bonding agents were applied to etched surface. A composite button of 5.3 × 3 mm (Z 100) was bonded to the test specimens and subjected to shear load using Instron Universal Testing Machine at the cross-head speed of 0.5 mm/min.

Results: Mean shear bond strength values in MPa of groups A, B, C were 21.483, 16.882 and 14.116 respectively.

Conclusion: Excite dentin bonding agent exhibited highest shear bond strength values as compared to Optibond solo plus and Prime and Bond NT, this difference was statistically significant. There was no statistically significant difference between the shear bond strength values of Optibond solo plus and Prime and Bond NT.

Keywords: Adhesion, Bonding agent, Moist dentin, Shear bond strength

INTRODUCTION

Dentistry focuses on the preservation and maintenance of natural teeth. A key goal of restorative techniques is to establish a bond between the mineralized tooth structure and the restorative material. An essential characteristic of any restorative material is its ability to form a durable bond with the tooth structure while exhibiting mechanical properties such as strength. Bonding refers to the adhesion of one material to another. A bonding agent can be defined as a substance that, when applied to surfaces, effectively joins them and resists separation[1]. In 1955, Buonocore introduced the acid etching technique using phosphoric acid, marking a significant advancement in adhesive dentistry[2]. Over the past few decades, considerable progress has been made, leading to the creation of bonding systems that not only adhere restorative materials to tooth structure but also to amalgam, composites, metals, and ceramics. Dentin adhesives have evolved from the initial generation, which had bond strengths of merely 1-3 MPa, to the current use of fifth, sixth, and seventh generation bonding systems[3-5]. The most

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frequently utilized bonding systems by dental professionals are the fifth generation single-component dentin bonding systems. This study aims to assess the shear bond strength of three such fifth generation dentin bonding agents.

The purpose of this in vitro study was to compare and evaluate the shear bond strength of three different fifth generation dentin bonding agents namely, Excite (Vivadent), Optibond solo plus (kerr), Prime and Bond NT (Dentsply) used in combination with composite resin.

MATERIALS AND METHOD

Forty-five non-carious human permanent molars, extracted for periodontal reasons, were utilized in this study. The teeth underwent cleaning with ultrasonic scalers to eliminate debris, stains, and calculus, and were subsequently stored in distilled water at room temperature. The occlusal surfaces of the specimens were ground using a straight diamond point with water coolant to reveal the superficial dentin. Following this, the specimens were further wet ground with 180 grit silicon carbide carborundum paper to achieve a flat occlusal surface that was perpendicular to the tooth's long axis. The test specimens were then embedded in chemically cured acrylic resin using a silastic mold, ensuring that the occlusal dentin remained exposed. To manage the exothermic heat generated during polymerization, the blocks were immersed in water. Finally, all prepared test specimens underwent additional dry and wet grinding with 320, 400, and 600 grit silicon carbide carborundum paper, respectively**.** All prepared test specimens were subsequently stored in distilled water. They were then randomly assigned into three groups, each containing 15 specimens, based on the dentin bonding agents utilized in the study:

Group A :Excite (Vivadent, Schaan/Liechtenstein)

Group B : Optibond Solo Plus (KERR, UK)

Group C: received Prime and Bond NT (Dentsply, USA).

The surface of each specimen was treated with 37% phosphoric acid gel for 15 seconds, followed by a 20-second rinse with water spray, and any excess water was removed by blotting with a moist cotton pellet, ensuring the tooth surface remained visibly moist. Bonding agents were then applied to the etched dentin surface in accordance with the manufacturer's guidelines and light-cured for 20 seconds using a visible light curing unit. A light-cured composite resin,

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Z 100 (3M Dental Products, USA), was subsequently placed on the occlusal surface to form a composite button measuring 5.3 × 3 mm, utilizing a silastic mold, and was light-cured for 40 seconds. Finally, all specimens were stored in distilled water for 24 hours before being subjected to shear load testing using an INSTRON Universal Testing Machine at a cross-head speed of 0.5 mm/min**.** Shear bond strength was calculated in megapascal units (MPa) by the ratio of maximum load in Newtons to the cross sectional area of the bonded interface in millimeters. Observation were tabulated and statistical analysis was done using‘t’ test and p-value < 0.001.

RESULTS:

Group A, which utilized the Excite dentin bonding agent, demonstrated shear bond strength values ranging from 15.956 to 24.377 MPa, with an average shear bond strength of 21.4832 MPa. In contrast, Group B, using the Optibond Solo Plus dentin bonding agent, showed shear bond strength values between 12.795 and 19.998 MPa, resulting in a mean shear bond strength of 16.8824 MPa. Meanwhile, Group C, which employed the Prime and Bond NT dentin bonding agent, exhibited shear bond strength values from 9.280 to 17.736 MPa, yielding a mean shear bond strength of 14.126 MPa. The mean and standard deviation values for shear bond strength in MPa across the three groups are presented in Table 2. According to the statistical analysis, group A exhibited a statistically significant difference in shear bond strength when compared to groups B and C. However, no statistically significant difference was observed in the shear bond strength between groups B and C. The comparison among the three groups is presented in Table 3.

Group	Bond strength Mean	 SD	 Range (min → max)
A (N = 15)	21.4832	±2.2762	15.956 → 24.377
B (N = 15)	16.8824	±2.6422	12.795 → 19.998

C (N = 15)	14.1126	±2.9398	9.280 → 17.736

Table 2: Mean shear bond strength (MPa)

Groups compared	Mean difference	SE	't' value	Significance
A vs B	4.6027	±0.9220	4.9474	$p < 0.001$
A vs C	7.3615	±0.9946	7.4289	$p < 0.001$
B vs C	2.7798	±1.0663	2.26321	$p < 0.001$

(By 't' test $p < 0.001$)

Table 3: Comparison of shear bond strength between groups

DISCUSSION

The groundwork for adhesive dentistry began in 1955 when Buonocore suggested that acids could modify the surface of enamel, making it more suitable for adhesion. He discovered that acrylic resin could adhere to human enamel that had been treated with 85% phosphoric acid for 30 seconds. Over the last few decades, there have been significant advancements in this field. The bonding of Bis-GMA to etched enamel enabled aesthetic restorations without requiring mechanical retention in cavity preparations. Initial attempts to bond dentin showed disappointing bond strengths. Enhancements and ongoing developments in bonding agents have led to various generations of dentin bonding systems.[7] Numerous studies have demonstrated that the latest dentin bonding systems offer greater bond strengths to dentin[3-5]. The fifth generation of bonding systems was designed to enhance the reliability of adhesive materials for dental practitioners. This generation includes two distinct types of adhesive systems: 'one bottle systems' and 'self-etching primer bonding systems.' In the current study, three one bottle dentin bonding agents from the fifth generation were utilized. These agents combine the primer and adhesive into a single solution, which is applied following the simultaneous etching of enamel and dentin (total etch). They achieve mechanical interlocking

with the etched dentin through the formation of resin tags, adhesive lateral branches, and a hybrid layer, demonstrating high bond strength to both etched enamel and dentin. Additionally, these bonding agents streamline the clinical process by minimizing the number of bonding steps, thereby reducing overall working time and helping to prevent the collapse of collagen in demineralized dentin. In the current investigation, group A exhibited the highest bond strength, with an average of 21.483 MPa, in comparison to groups B and C, which recorded mean shear bond strength values of 16.881 MPa and 14.116 MPa, respectively. Statistical analysis revealed a significant difference in shear bond strength for group A when compared to groups B and C. However, no significant difference was found between the shear bond strengths of groups B and C. The bonding agent, Excite, comprises hydroxyethyl methacrylate (HEMA), dimethacrylates, phosphoric acid acrylates, highly dispersed silicone dioxide, along with initiators and stabilizers in an alcohol solution, facilitating rapid reaction and ensuring long-term stability. Numerous studies have indicated that the application of 2-HEMA monomer to a conditioned dentinal surface enhances bond strength, which likely accounts for the superior bond strength observed in this group[8-11]. Excite, formulated with an alcohol solvent, offers greater technical tolerance due to its lower volatility compared to acetone, making it less sensitive to variations in dentin moisture. In contrast, acetone can cause significant dehydration of dentin and evaporates rapidly. As an acetone-free solvent, Excite strikes an effective balance between water and highly volatile solvents like acetone.

Optibond Solo Plus is formulated with a mixture of water, ethanol, HEMA, Bis-GMA, dimethacrylates, photoinitiators, and pyrogenic (fumed) amorphous silica, along with alkali fluorosilicates (Na). The presence of HEMA appears to have an increased affinity for dentin when paired with water-displacing solvents such as ethanol. This combination can effectively displace water from the dentin surface, allowing for better infiltration of the monomer through the nanospaces within the dense collagen matrix, thereby improving bond strength. It has been proposed that the water component in certain adhesive formulations may help to reopen the collapsed collagen fiber network in areas that have dried out, thus preventing the development of ghost hybrid layers[12,13]. The shear bond strength results from the current study align with findings from other research documented in the literature[14,16]. Prime and Bond NT is an acetone-based adhesive formulated with Di and Trimethacrylic resin, PENTA (dipentacrythritolpenta acrylate monophosphate), nano-fillers, amorphous silicon dioxide

photoinitiators, stabilizers, and cetylamine hydrofluoride. For optimal bonding, it is essential to maintain a moist dentin surface. This adhesive functions as a water chaser, facilitating the diffusion of the primer into both the dentin and the substrate[16]. It is particularly sensitive to the moisture levels on the dentin surface; even minor drying can significantly diminish bond strength. In studies assessing shear bond strength among various formulations of Prime and Bond NT, such as Prime and Bond 2.0—which shares a similar composition but includes fluoride—and Prime and Bond 2.1, the latter was found to be comparable to the formulation used in the current research. However, Jeorge P reported a lower shear bond strength for Prime and Bond 2.1 in their findings. Research by Vijay M and Mano CA indicated that the shear bond strength values for Single Bond and Prime and Bond NT align closely with the results of the present study[14].

CONCLUSION: This study aimed to conduct a comparative analysis of the shear bond strength of three fifth-generation dentin bonding agents: Excite (Vivadent), OptiBond Solo Plus (Kerr), and Prime and Bond NT (Dentsply).

The findings led to the following conclusions:

1. The Excite dentin bonding agent demonstrated the highest shear bond strength values when compared to Single Bond and Prime and Bond NT, with this difference being statistically significant ($p < 0.001$).

2. No statistically significant difference ($p < 0.001$) was found when comparing the shear bond strength of Single Bond and Prime and Bond NT.

REFERENCES

1. Kinloch AJ, Hall CP. A review of adhesion and adhesives: science and technology. London and New York 1987, 441. The Journal of Adhesion 1989;28.

2. Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. J Dent Res 1995;34:849-853

3. Davidson CL. An investigation into the quality of dentin bonding systems for accomplishing a durable bond. Journal of Oral Rehab 1993;20:291-300.

4. Tyas MJ. Clinical evaluation of five adhesive systems. Am J Dent 1994;7:77-80.

5. Van Meerbeek B. Clinical status of ten dentin adhesive systems. J Dent Res 1994;73:1690-1702.

6. Bowen RL. Dental filling materials comprising vinyl-silane treated fused silica and a binder consisting of the reaction product of bisphenol and glycidylmethacrylate. US Patent 1962;3:066,112.

7. Cerard K, Ferrari M. The science of bonding: from first to sixth generation. J Am Dent Assoc 2000;131:20-25.

8. Nakabayashi N. Effect of HEMA on bonding to dentin. Dent Mater 1992;8:125-130.

9. Gerbeno C, Nakabayashi N. Effect of HEMA treatment on bonding to EDTA pretreated dentin. J Dent Res 1992;71:615 (abstract 798).

10. Erikson RL. Mechanism and clinical implication of bond formation for two dentin bonding agents. Am J Dent 1989;2: 117-123.

11. Munksgarrd EC, Asmussen E. Bond strength between dentin and restorative resins mediated by mixtures of HEMA and Glutaraldehyde. J Dent Res 1984;63:1087-1089.

12. Van Meerbeek B. A TEM study of two water based adhesive systems bonded to dry and wet dentin. J Dent Res 1998;77: 50-59.

13. Tay FR. Micromorphological spectrum from overdrying to overwetting acid conditioned dentin in water-free, acetone-based, single-bottle primer/ adhesives. Dent Mater 1996;12: 236-244.

14. Perdigao J. In vitro interfacial relationship between human dentin and one-bottle dental adhesives. Dent Mater 1997;13: 218-227.

15. Ali Al Ehaideb, Mohammed H. Shear bond strength of one bottle dentin adhesives. J Prosthet Dent 2000;84:408-412.

16. Jonathan R, Lakshminarayanan L. Comparison of shear bond strength of fifth generation dentin bonding agents: in vitro study. J Cons Dent 2001;4:122-129.

17. Fritz UB, Finger WJ. Resin modified glass ionomer cements: bonding to enamel and dentin. Dent Mater 1996;12:161-166.

18. Vijay M, Angelo MC, Mariamma KC, Jayakumar K, Sarath BK. Comparative evaluation of the effect of 15% carbamide peroxide bleaching on shear bond strength using three different adhesive systems: an in vitro study. IJAPBS 2013;2:18-23

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