

Comparison of shear bond strength between 7th and 8th generation bonding agents in flowable composite resin

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Abstract

Background: Aesthetics, function and structure of teeth are the focus in patient care. A demand for aesthetic dentistry mainly attributed to patient discontent with tooth color. The increased interest in aesthetic dentistry prompted the development of systems aiming for efficient bonding of enamel and dentin through simplified processes. Bonding is a crucial component contributing to the enhancement of the biomechanics and aesthetics of teeth. The last two decades, bonding agents are rapidly evolving. Generation 7 is self-etch bonding agent, containing etch, primer, and bonding in a single package. Generation 8 bonding is a universal adhesive containing nanofillers to increase the thickness of the hybrid layer and enhance the mechanical properties. Highly filled flowable composite resin also have nanofillers that improve mechanical and aesthetic characteristics. The shear bond strength test serves as an assessment tool for the efficacy of bonding agents.

Purpose: To determine the difference in shear bond strength of generation 7 and 8 bonding agents in flowable composite resin.

Methods: Flowable composite resin samples were applied to the enamel of human upper permanent incisors. The control group used generation 7 bonding agents, while the treatment group used generation 8 bonding agents. Testing was conducted using a Universal Testing Machine.

Result: The data were normally distributed, not homogeneous, and did not show significant differences. The control group showed an average shear bond strength of 4.77 MPa, while the treatment group showed a slightly higher average of 5.13 MPa.

Conclusion: Generation 7 and 8 bonding agents have equivalent shear bond strength.

Keywords: Shear bond strength; Bonding agent; Flowable composite resin

1. Introduction

The aesthetics, function, and supporting structures of the teeth are very important to consider in overall patient care. Aesthetic dentistry is a rapidly growing and highly desired treatment¹. The increasing interest in aesthetic dental restoration has encouraged the creation of various systems aimed at achieving effective bonding of enamel and dentin through processes that preserve them². Bonding agents are an important aspect in restorative procedures to improve the biomechanics and aesthetics of the tooth structure³.

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Bonding agents are currently classified into 8 generations. Generation 7 bonding is a single stage self-etch adhesive bonding (a component that can function as etching, priming and bonding in one solution). Generation 8 bonding materials are categorized as universal adhesives bonding agents whose application can use total-etch, self-etch, and selective-etch techniques and use nanofillers which increase the thickness of the hybrid layer, resin monomer penetration, and the mechanical properties of the bonding agent⁴.

Nanotechnology in dentistry involves manipulating objects with nanoparticles, such as nanofillers in flowable composite resin⁵. This results in a more homogeneous filler load, increasing resin load and improving mechanical and aesthetic characteristics. Flowable composite resin is low viscous material that allowed easier flow and adaptability to tooth cavities. The latest type is available in various colors and translucency levels for patient aesthetics. The shear strength test is a significant evaluation of bonding agents, with recommended value 14-30 MPa^{4,6,7}.

2. Material and methods

2.1. Material

2.1.1. Tools

The materials used in this research included tools for cutting and smoothing prepared teeth (diamond disc, contra angle handpiece NSK (Japan), micromotor, and silicon carbide paper #1000), chip blower, microbrush, measuring cups, scales, porcelain pots, spatula, excavator, composite resin molding tools, acrylic resin molding tools, clamp-C, Light Curing Unit with intensity 700-1200 mW/cm^2 and Universal Testing Machine with the following specifications:

- a. Maximum Load: 20 Kg / 200N
- b. Load Accuracy : 0.05%
- c. Speed Range: 5 - 20 mm/min
- d. Return Speed: 30 mm/min
- e. Test Category strength: Tensile, Compression, Bending, Shear bond
- f. Safety Device : : Emergency Stop, Up-Down Limit
- g. Dimension (W x D x H) : Approx. 450 x 450 x
- h. Power: AC 220V, 50/60 Hz

2.1.2. Materials

Human maxillary permanent incisor tooth, saline solution, flowable composite resin (G-aenial universal injectable, GC Tokyo), bonding agent generation 7 (G-bond, GC Tokyo), bonding agent generation 8 (G-premio bond, GC Tokyo), hillon self-cured acrylic resin (England).

2.2. Methods

The type of research carried out is laboratory experimental research. The sample used in this study was a combination of flowable composite resin applied to the enamel of a human maxillary permanent incisor tooth, using bonding agents generation 7 and 8 after the tooth was fixed in acrylic resin. The samples used were calculated based on World Health Organization (WHO) standards using the Lemeshow formula, then the samples were divided into two groups (6 samples each). Group 1 contains generation 7 bonding agents and Group 2 contains generation 8 bonding agents.

3. Results and Discussion

The results obtained from shear strength testing using the Universal Testing Machine are in the form of force (F) in Newtons (N). Then, to obtain the shear strength, the magnitude of the force is divided by the surface area (A) in units of millimeters squared (mm^2). Then the shear strength (τ) will be obtained in megapascal units (MPa) which can be seen in table.

Based on the research results and data analysis, it was found that there was no significant difference between the shear strength of generation 7 and 8 bonding. The two bonding agents used in this research have similarities, namely the self-etch application technique, 4 MET functional monomer, and silicate filler content⁸. Both bonding agents contain 4-MET which consists of methacrylate units forming a covalent relationship with a methacrylate-based resin material, (flowable composite resin). Methacrylate-based resins undergo gradual monomer polymerization, then transition to a solid through polymerization involving C=C double bonds in the methacrylate group⁹.

Table 1 Shear Strength Test Results

Group	N	Average	S.D
Control (Bonding Agent Generation 7)	6	4.77 MPa	3.26
Treatment (Bonding Agent Generation 8)	6	5.13 MPa	1.43

The functional monomer 4-MET has hydrophilic characteristics that help the bonding agent infiltrate into the moist enamel surface. This increases the ability of the bonding to spread and adhere more effectively, apart from that 4-MET also has a function as a coupling agent which facilitates the chemical relationship between the organic elements of the bonding agent and the mineral elements of the tooth structure, namely hydroxyapatite in the enamel, thus increasing the adhesion and bonding ability of the bonding agent^{10,11}. The use of 4-MET as a bonding agent can help reduce microleakage which can cause bacteria to enter between the tooth and the restoration material. In the nano interaction zone, 4-MET monomer reacts with hydroxyapatite in the enamel to form insoluble calcium compounds which can produce a layer that is not enzymatically damaged¹².

Silicate fillers in bonding agents improve mechanical properties and minimize shrinkage during polymerization. They initiate calcium-phosphate precursors and attract calcium particles, leading to bioactive calcium-silicate compounds¹³. Generation 8 bonding agents have nanofillers less than 20 nm, increasing bond strength and creating a thicker hybrid layer. Flowable composite resin contains silicon dioxide filler (16 nm) and strontium glass 200 nm, increasing filler content and improving mechanical and physical properties. Nanofillers result in a more consistent filler distribution and denser arrangement of nanofiller particles, leading to increased cohesion and adhesion, resulting in high shear strength test results⁶.

According to references 14-30 MPa is suggested as a benchmark for shear strength¹⁴. However, this value was not achieved in this research as was the case in research conducted by previous research, who only got an average of 3 MPa in the 8th generation bonding shear strength test¹⁵. This can be influenced by the tooth surface and testing equipment^{7,16}. Based on the research results, there is no significant difference in bonding agents generation 7 and 8 as found in research by Al-Ashou *et al*¹⁷. Therefore, bonding generations 7 and 8 have equivalent shear strength so they can be used to attach flowable composite resin.

4. Conclusion

There is no significant difference between generation 7 and 8 bonding agents, they have equivalent shear strength. This research still needs to be carried out further research using a Scanning Electron Microscope (SEM) to determine failure modes of fracture and to see the attachment to the enamel surface and flowable composite resin after application of generation 8 bonding.

Compliance with ethical standards

Disclosure of conflict interest

No conflict of interest to be disclosed.

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