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An In-Vitro Investigation for Comparative Assessment of Shear Bond Strength of Two Distinct Generations of Dentin Bonding Agents

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Abstract:-

- ***Aim:***
  To compare and assess the shear bond strength of two distinct generations of dentin bonding agents.

- ***Material and Methods:***
  Thirty-four extracted human premolars were collected for the study. The teeth's occlusal surfaces were decreased to expose the flat surface of dentin and randomly divided into two experimental groups (n=14). Group I- Seventh generation dentin bonding agent Group II- Eighth generation dentin bonding agent. Following the manufacturer's directions, bonding agents were applied and light-cured. On these prepared dentinal surfaces, a plastic mould was used to create composite cylinders. A Universal Testing Machine was used to determine the shear bond strength of each sample.

- ***Results:***
  When compared to seventh generation dentin bonding agent, the eighth generation dentin bonding agent shows highest shear bond strength value and demonstrated a statistically significant difference.

- ***Conclusion:***
  The study concluded that the shear bond of eighth generation bonding agents is stronger than that of seventh generation bonding agents.

Keywords: *(Bond Strength, Dentin Bonding Agents, Universal Testing Machine).*

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I. INTRODUCTION

During the last three decades, clinicians have had to deal with the ongoing and relatively quick development of adhesive materials. The first commercially available restorative resin composites were introduced in the middle of the 1960s, and the acid etch method was initially used in clinical practice in the early 1970s. Since then, there has been continuous development in manufacturing more advanced and different restorative materials as well as producing superior bonding agents. [1,2]

In contemporary restorative dentistry, adhesive bonding to tooth structure has been a crucial component that enhances the biomechanical and aesthetic quality of restorations. Dentin bonding refers to the micro-mechanical adherence of composites and other restorative materials to human dentin via an adhesive resin layer in between. [2,3]

Over many generations, dental adhesive systems have undergone changes in their chemistry, mechanism of action, number of steps in the process, application technique, and

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clinical efficacy. Self-etching adhesives offer several benefits compared to etch and rinse adhesives. [4]

First off, self-etching adhesives require a less technique-sensitive procedure because the etch and rinse step is not essential for them, which could lead to the collapse of the delicate demineralized collagen network following acid etching. Second, an optimally infiltrated hybrid layer should result from the concurrent demineralization and resin penetration. [5]

Cavities are placed using an adhesive technique after composite resin restorations are placed. For any resin to be used successfully in clinical settings, it's surface adhesion degree and chemical stability is essential. [6]

The word "adhesion" comes from the Latin word "adherence," which means to stick. Adhesion is the term used to describe the forces or energy between atoms or molecules that hold two phases together at a contact. [7,8] To encourage adherence between composite resin and dental structure, bonding agents are utilized. There are three-step, two-step, and single-step systems for dental adhesives depending on their methods used to etch, prime, and bond the tooth surface. [9-12]

Among these, single-step self-adhesives are growing in popularity because of how simple they are to use. There will be less mistakes made when applying the adhesive if there are fewer phases in the process. This is frequently referred to as single-step self-etching adhesives' "low technique sensitivity".[4]

In vitro testing are important because they can quickly and affordably provide the information needed on the efficacy of new materials. Shear bond strength testing is the most often used laboratory metric for assessing the efficacy of dentin bonding agents. The tendency of shear bond strength is to prevent one body part from slipping over another. Inadequate bonding and larger spaces between the resin restoration and the tooth are linked to low shear bond strength. [14,15]

Thus, the aim of this in-vitro study was to compare and assess the shear bond strength of two distinct generations of dentin bonding agents using Universal Testing Machine (UTM).

II. MATERIAL AND METHOD

- Thirty-four (34) freshly extracted human premolars which were intact, non-carious, and unrestored were chosen; teeth having restorations, dental abnormalities, and carious teeth were not included.
- After being cleaned of blood and saliva, collected teeth were kept in a saline solution. When handling teeth, gloves, a mask, and safety glasses were always worn. The teeth were polished using a pumice and water slurry, dried, and then used for study.
- A custom-made modelling wax mould measuring 1.5 cm in width and c 2 cm in height was utilized to place the teeth in cold-cure acrylic resin vertically.
- To reveal the flat dentin surface, the occlusal surfaces of the teeth were reduced using a 245 carbide bur under continuous water spraying.
- Two groups of 17 specimens each were created from the collected samples (n=17).

➢ Group I- Seventh generation dentin bonding agent.
➢ Group II- Eighth generation dentin bonding agent.

- In each group, the tooth surface was cleaned and blotted dry. As per the manufacturer's instructions, a microbrush was used to apply bonding agent to the surface, which was then light-cured. Using a plastic mould measuring 3 mm diameter and 2 mm height, apply composite resin in two-layer increments which was light-cured for 40 seconds.

➢ *Shear Bond Strength Measurement*

- Each sample underwent a shear bond strength evaluation.
- The shear bond strength was determined using a Universal Testing Machine (UTM). The sample was securely fastened to the machine and compelled to a compression mode shear stress in the UTM at a 1.5 mm/minute cross-head speed.
- In order to place the shearing blade perpendicular to the composite-dentin interface, the bonded composite cylinder was placed in a horizontal position. Until it failed, each sample was packed. The shear force needed to break the sample's binding was noted. MPa was used to calculate the bond strength.

III. RESULT

Data obtained was then tabulated and statistically analysed. (Table 1 and 2).

Table 1: Mean and Standard Deviation of Bond Strength of Two Groups (MPa).

Bond Strength	Mean	Std. Deviation	S.E. Mean
7th Generation	17.43	0.42	0.07
8th Generation	26.89	0.62	0.11

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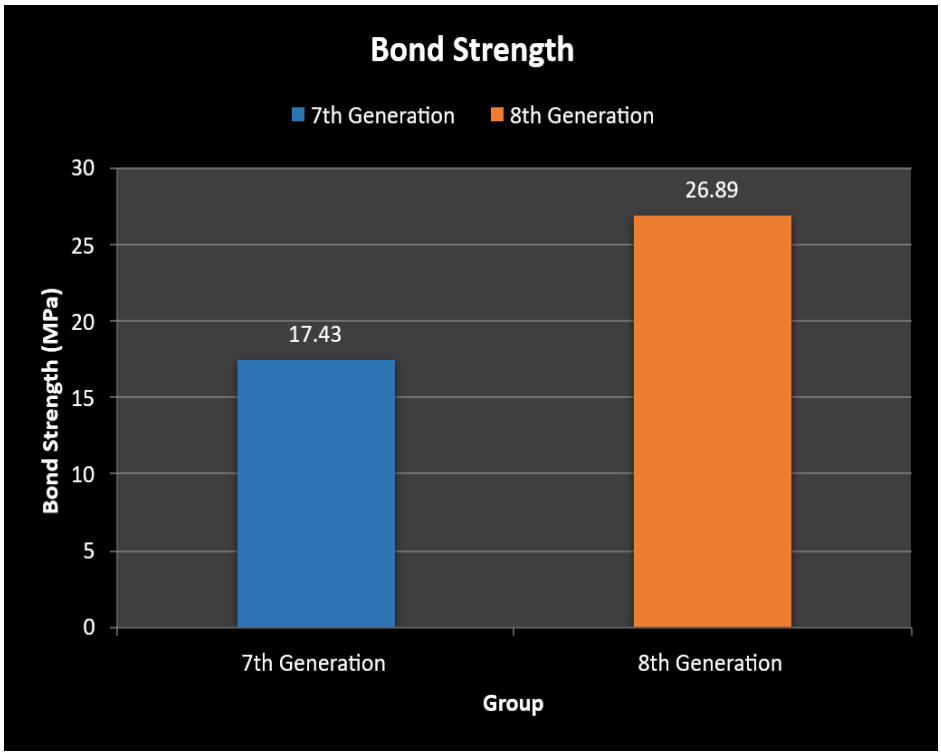
Table 2: Comparison of Bond Strength Between the 7th and 8th Generation Bonding Agent.

t	df	P Value	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference		Inference
					Lower	*Upper*	
73.56	66	0.000	9.46	0.13	9.72	9.2	Significant

It was discovered that the mean shear bond strength was considerably higher for Group II (eighth generation) dentin bonding agent (26.89MPa) as compared to Group I (seventh generation) dentin bonding agent (17.43MPa).

The difference between the seventh and eighth generation bonding agents mean shear bond strength is significant since the P value is 0.000 ($P < 0.05$).



Graph 1: Comparison of Mean Shear Bond Strength Between Two Groups

IV. DISCUSSION

Assessing a bonding agent's retention to the dental hard structures is the primary goal in determining its bond strength.

The goal of advancements has been to improve the bonding quality and shorten the time consumption in application.

The tooth type, dentin surface, bond strength type (shear or tensile), bonding chemical utilized, storage medium, composite restorative material, and testing methodology all influence bond strength. [7]

The current study was conducted in vitro since in vitro research is crucial for the development of novel materials and helps clinicians comprehend the mechanical, biological, and physical properties of dental materials. [16]

Shear bond strength is the most frequently used laboratory metric for evaluating the efficacy of dentin adhesive solutions systems. Bond strength assessment is justified by the idea that an adhesive's actual bonding capacity determines how well it can tolerate stresses and how long the restoration will endure in vivo. [15,17,18]

The Universal Testing Machine is widely used to evaluate the adhesive capacity of adhesive/restorative materials, [19] was employed in this study as well as to assess the bonding strength of dentin bonding agents of the sixth, seventh, and eighth generations. [20] According to some of these articles, the eighth generation dentin bonding agent exhibited the highest bond strength, which was also observed in our investigation.

In this investigation, dentin bonding agents from the seventh and eighth generations were used. The mean shear bond strength of eighth generation dentin bonding agents is higher than that of seventh generation dentin bonding agents.

Although both generations of dentin bonding agents contain functional monomers, cross-linking monomers,

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solvent, inhibitors, and activators, the eighth generation is said to have a greater shear bond strength because it has more micro-sized cross-linking functional monomers than the seventh generation. Self-etched adhesive systems' chemical basis, particularly the functional monomer has a major impact on the long-term bonding efficacy of these systems. [7]

2-hydroxyethyl methacrylate (HEMA) monomer is added to the seventh generation one-bottle dentin bonding solution to increase the dentin surface's wettability. HEMA helps to fortify the connection between the hydrophobic composite resin and the hydrophilic dentin collagen. [21] The recently developed dentin bonding agents of eighth generation are self-etching, dual cured, and created bond strengths that are similar to those of enamel and dentin. They are thought to produce less discomfort after surgery because of their mild pH. [20]

As compared to etch and rinse adhesives, eighth-generation dentin bonding agents decrease dentinal fluid flow by using the smear layer as a bonding substrate and leaving behind residual smear plugs. These gentle self-etching adhesives allow hydroxyapatite crystals to be chemically bonded to calcium by functional monomers, potentially improving contact stability.[4]

There was a statistically significant error amongst the seventh and eighth dentin bonding agents generations. The same could be explained by the following factors-

- Eighth generation dentin bonding agent uses 4-methyacryloyloxyethyl trimellitic anhydride (META) as an adhesion-promoting monomer. Methacryloyloxydecyl dihydrogen phosphate (MDP) functional monomer creates an iconic connection with hydroxyapatite more easily and intensely, which causes chemical bonding to dentin substrate. Acetone, the solvent employed in this adhesive, enhances wetting and demineralization by inhibiting the esterification of carboxylic acid groups. Acetone also has a powerful ability to chase water. [22]

- Eighth-generation dentin bonding agents lack 2-hydroxyethyl methacrylate (HEMA), which is present in seventh-generation dentin bonding agents. To make Bis-GMA more soluble and create a strong, highly cross-linked polymer network large amounts of these hydrophilic monomers are added. Nevertheless, HEMA absorbs water following polymerization, which results in water sorption, hydrolytic breakdown, and a decrease in bond strength.[21]

This could explain why the dentin in this present study had a strong shear bond for eighth-generation dentin bonding agent as compared to a seventh-generation dentin bonding agent.

V. CONCLUSION

The eighth-generation dentin bonding agent demonstrated a significantly higher mean shear bond strength to dentin than the seventh-generation dentin bonding agent, as per the study's limitations.

However, additional study is required to determine the bond strengths of these recent generations of adhesive solutions under therapeutically acceptable conditions.

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