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Effect of Hydrophilic Amide Monomers on Dentin Bonding Strength

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Abstract **Objective:** The aim of this study was to compare the shear bond strength (SBS) to dentin of one-step bonding agent containing hydrophilic amide monomers (HMA) and 10-Methacryloyloxydecyl dihydrogen phosphate (MDP) with one-step bonding agent containing only MDP. **Materials and Methods:** 20 human third molar teeth randomly were divided into two groups. Teeth was abraded with a SiC disc (Carbimet, Bisco Inc., Schaumburg, USA) to be under 1 mm of enamel-dentin junction. The dentin surface of each teeth were etched with %37 phosphoric acid for 15 s and then rinsed with water spray for 10 s and after that air dried. Cylinders of composite (Clearfil Majesty Posterior, Kuraray Noritake Inc, Okuyama, Japan) were bonded using 2 dental bonding agents. Group A used bonding agent containing HMA+MDP (Clearfil Universal Quick bond, Kuraray America, Inc. New York/NY, USA) and Group B used bonding agent containing only MDP (Clearfil S3 Bond plus, Kuraray America, Inc. New York/NY, USA) applied in accordance with the manufacturer's instructions. The speciemens were stored for 24 h in 37°C water and thermocycled between 5 and 55 C water with a 20 s dwell time for 5000 cycles. They were then submitted to a shear bond test with a universal testing machine (AGS-X, Shimadzu, Kyoto, Japan) with a 100 N load cell at 1 mm/min. The values of SBS were analyzed with ANOVA/Tukey's test. **Results:** Group A was 35,96±5,47 MPa and B was 24,25±7,5 MPa There was a statistical difference between the two bonding agents ($p<0.05$). Group A was significantly higher than Group B. **Conclusions**: According to this study, bonding agents containing which type of monomers may be one of the important factors influencing dentin bond strength. When bonding agents with hydrophilic amide monomers are used, it has showed higher shear bond strength.

Keywords: *hydrophilic amide monomers, dentin bonding, shear bonding strength, polymerization time*

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1. Introduction

For dental tissue bonding, dentin bonding systems consist primarily of synthetic resin monomers that can partially leak into the demineralized dental structure. These systems include hydrophilic and/or hydrophobic monomers, photo-initiators, stabilizers, solvents and inorganic fillers [1]. Depending on the mode of operation, the current adhesives can be used according to two major adhesion strategies. These are: "etch & rinse" (ER) in which phosphoric acid is to be etching; and "self-etching" (SE) where no etching is needed [2]. Selective etching is an adhesion strategy that combines ER and SE with acid application only to enamel and applies multi-mode or universal adhesive to both enamel and dentine [3,4].

Self-adhesives are commonly used due to their user-friendly, simple application. [5] Today, the use of aggressive self-adhesives is gradually decreasing due to its comparatively weak dentin bond strength [6]. Less aggressive self-etching adhesives have eventually become the major goods. [5] However, these adhesives cannot completely dissolve the dentin smear layer. They will provide hybridization with dentin smear layer to form a 'resin-smear layer complex' [7]. Therefore, the weakest connection exists at the resin-dentin interface when using these adhesives. [8].

Universal adhesives are the latest generation dentin bonding system. [9] Universal adhesives are designed to bond to dental structures by both chemical and micromechanical mechanisms due to the existence of certain functional monomers, such as 10-methacryloyloxydecyl dihydrogen phosphate (MDP). [10,11,12] These added monomers, on the one side, form a chemical bond with calcium in hydroxyapatite crystals, while at the same time forming a hybrid layer polymerized on the other ends. [13]

The purpose of this study is to compare the bonding strength of dentin bonding systems containing hydrophilic

amide monomers and containing 10-Methacryloiloxidesyl dihydrogen phosphate (MDP) to dentin tissue in an attempt to shed light on their clinical use.

2. Material and Methods

In this study, 20 non-carious third molar teeth were used. To create a smooth occlusal dentin surface, the occlusal enamel was removed with a SiC disc (Carbimet, Bisco Inc., USA), below the 1 mm enamel-dentin boundary. Teeth were embedded in cylindrical acryl blocks with exposed dentin surfaces exposed. Dentin surfaces were abraded with 600 gr sandpaper and a standard smear layer was created. The samples were randomly divided into 2 groups (n = 10).

Universal adhesive systems were applied to the dentin surfaces prepared according to the manufacturer's instructions (Table 1). It was polymerized with a powerful LED light source (ValoLed, Ultradent Products Inc, Utah, USA) in the required time. All groups were restored with 4 x 4 mm sized nanohybrid composite discs (Clearfil Majesty Posterior, Kuraray, Japan).

Samples were kept in 37 °C water for 24 hours and a thermal cycle of 5 to 55 °C was performed for 5000 cycles with a 20 second standby time. They were subjected to shear bond strength testing with a universal tester (AGS-X, Shimadzu, Japan). The breaker tip was positioned on the composite parallel to the bonding surface. The composites were broken by applying shear force at a speed of 0.5 mm / min. Maximum strength values were determined and the results were calculated in MPa. The statistical analysis of the obtained data was done with One Way Variance Analysis and Tukey HSD.

Table 1. The materials and forms of application

Groups	Product name	Composition	Application Method	Manufacturer
Group A	Clearfil Universal Bond Quick	• HEMA • Bisphenol A diglycidylmethacrylate (BIS-GMA), • 10-methacryloyloxydecyl dihydrogenphosphate (MDP), • Hydrophilic amide monomers • Colloidal silica • Silane • Sodium fluoride • Ethanol • Water	1. Bond application 2.5 minutes drying with suction 3. 5 sec light application with powerful LED light device	Kuraray America, Inc. New York/NY, USA
Group B	Clearfil S3 Bond	• 10-MDP • HEMA • Bis-GMA • Hydrophilic and hydrophobic aliphatic dimethacrylates • Colloidal silica • Silan • Sodium fluoride • Ethanol • Water	1. Bond application and 10 sec standby 2. 5 sec air drying and spreading 3. 10 sec light application	Kuraray America, Inc. New York/NY, USA

Table 2. The mean of shear bond strength (MPa)

	n	Mean(MPa)± Standard Deviation
Group A	10	35,96±5,47
Group B	10	24,25±7,5

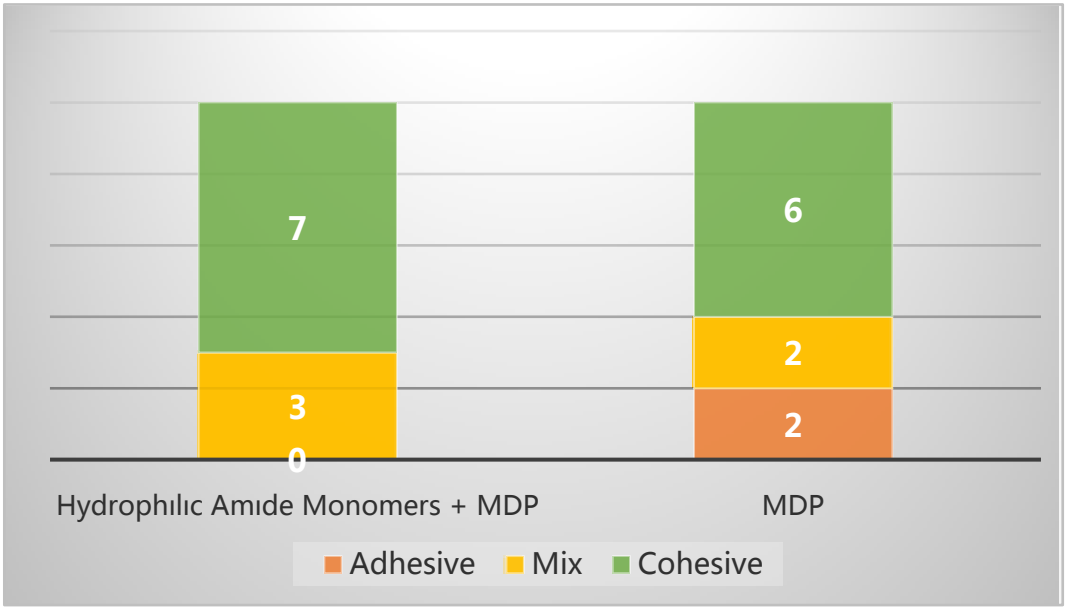

Figure 1. Fracture patterns

3. Results

Shear bond strength is shown in Table 2.

The mean shear bond strength of Clearfil Universal Bond Rapid was measured at 35.96 ± 5.47 MPa and the mean shear bond strength of Clearfil S3 Bond was measured at 24.25 ± 7.5 MPa. As a consequence of the statistical assessment, the discrepancy was important when comparing the bond strength between groups ($p<0.05$). The forms of refraction were calculated by a light microscope. (Figure 1).

4. Discussion

In this study, when the shear bond strength of the universal adhesive systems was compared, it was seen that the materials had different results despite having a similar application procedure.

Universal systems are one-step self-etch systems. Self-etch primers also produce an acidic monomer that dissolves the coating layer and also demineralizes the dentin. The variations in bond strength between bonding structures can be due to various acidic monomers in the substance of the products. [14] Therefore, in our study, bonding systems with the same acidic monomers were used.

Poggio et al. [5] stated that the pH value of universal bonding systems does not substantially influence the shear bond strength of the enamel and dentin surfaces. It may be attributed to the significant effect of the pH concentration and the formation of the 10-methacryloloyloxidesyl dihydrogen phosphate (MDP) universal bonding systems. [16]. At the other hand, Nishiyama et al. [17] quantitatively investigated the effects of MDP at universal bonding systems without MDP-based2-hydroxyethyl methacrylate (HEMA). These study showed that HEMA, a hydrophilic monomer, increases the bond strength with MDP. [17]

HEMA is a monomer seen in a variety of fields today, including contact lenses. It is also used as a monomer with high water absorption in universal bonding agents. Although this feature facilitates the attachment to dentin, it also causes the appearance of a "water-tree" which reduces the binding strength in the long term. [18] The amide monomers in Clearfil Universal Bond Quick have quick penetration of the dentin surface while reducing the harmful effects of HEMA. That is why Clearfil Universal Bond Quick offers greater shear bond power in our research.

Universal bonding systems are preferred in clinical applications due to their additional applications and reduced time loss. Clearfil Universal Bond Quick fulfills one of the preferred reasons for universal bonding systems, as it does not require waiting time after application and polymerizes with 1500 mW / cm2 in 5 seconds. [19]

5. Conclusion

According to this study, the content of hydrophilic monomers is an important factor in the bond strength of dentin bonding systems. Dentin bonding system containing hydrophilic amide monomers showed shorter working time and higher shear bond strength.

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