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The effect of water storage on micro-shear bond strength of contemporary composite resins using different dentin adhesive systems

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Abstract

Purpose: To evaluate effect of water storage on micro-shear bond strength of adhesives to class I cavity-bottom dentin using two types of composites resin.
Materials and methods: Ninety teeth were divided into three groups I,II&III (thirty molars each) according to the adhesive used, either total-etch 2-step (Adper Single Bond, 3M ESPE), self-etch 2-step(Clearfil SE Bond, Kuraray), or self-etch 1-step(Futura Bond, Voco) respectively. Each group was subdivided according to type of composite restoration used, either Hybrid (Clearfil APX, Kuraray), and Packable (Filtek P60, 3M ESPE). All teeth were thermocycled for 500 cycles,and subjected to occlusal load cycling for 120.000 cycles corresponding to 6 months clinical use. Bonding effectiveness was assessed by micro-shear bond strength test (μSBS) after 1 day, 3 months, and 6 months water storage.
Results: The mean μSBS values (±SD) for Subgroup IA(SB2-APX) were 32.58 ± 1.416, 31.820 ± 2.119, and 30.910 ± 1.393 MPa after 24 h, 3 month, and 6 month respectively; while for Subgroup I B(SB2-P60) were 31.960 ± 1.659, 31.350 ± 1.765, and 30.380 ± 1.773 MPa respectively. Subgroup II A (CSE-APX) recorded 37.28 ± 1.061, 36.77 ± 2.32, 36.21 ± 1.964 MPa, while Subgroup II B(CSE-P60) recorded 37.0 ± 2.115, 36.460 ± 1.727, and 36.080 ± 1.910 MPa after 24 h, 3 month, and 6 month respectively. Subgroup III A (FB-APX) showed 30.550 ± 2.088, 26.890 ± 1.533, and 21.590 ± 1.784 MPa, while subgroup III B (FB-P60) showed 29.790 ± 1.172, 25.960 ± 2.672, and 21.410 ± 2.126 MPa after 24 h, 3 month, and 6 month respectively.
Conclusion: Two-step Total-etch and Two-step self etch adhesives showed better tolerance to water storage compared to One-step self-etch adhesive. However, the type of composite restoration had no significant effect on the microshear bond strength of dental adhesives.
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Keywords: Water storage; Microshear bond strength; Adhesives; Composite resin

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1. Introduction

Lately, restorative dentistry has undergone an important paradigm shift. The concept of drill & fill by G.V. Black, has been replaced by the current trend of 'minimally invasive' dentistry, which is based upon minimizing the loss of sound tooth structure [1].

Resin bonded-composite has been introduced as a restorative material for posterior teeth [2,3]. The success of these restorations depends on bonding them to hard tooth tissue that will retain the restoration to the cavity preparation and prevent microleakage [4].

The principles of adhesive dentistry date back to 1955 when using techniques of bonding, postulated that acids could be used as a surface treatment before application of the resins [5], and found that etching enamel with phosphoric acid increased the duration of adhesion under water. However, bonding to dentin has a less reliable result due to its characteristics {collagen content, variable tubular structure, and outward dentinal fluid movement} [2]. Dentin bonding was further complicated by the presence of smear layer [6], age of teeth, direction of tubules and type of dentin [7].

Dentin bonding agents have been introduced to improve the adhesion to tooth structures, and to overcome these difficulties. Now, they are available in single-bottle systems to facilitate their use [8].

Manufacturer have improved the clinical performance of resin composite as posterior restorative materials; a recent type is *Packable composite*, in which there is incorporation of modified ceramic fibers (aluminum oxide & silicon dioxide) in addition to, or in place of, conventional inorganic filler particles. The ceramic fibers conduct light and allow curing depth up to 6 mm, thus allow for bulk placement of material and less curing time at chairside. Additionally, Packable resin composites have decreased polymerization shrinkage and increased wear resistance [9,10].

Studies evaluating the bond strength of different adhesive materials showed divergent findings. While some studies reported high bond strength [11–13]; other, however, showed lower values [14–16]. An explanation was given to the variation in the test methods between these studies.

The durability of the adhesive bond between resin and tooth structure is of significant importance for longevity of adhesive restorations. Long term stability of resin bonded dentin remains questionable. Hashimoto et al 2000 [17]demonstrated that the resin-dentin bond structures degraded in particular at the area of the hybrid layer when subjected to aging. *In vitro* laboratory studies reported decrease in bond strength after long water storage [18,19].

Cycling masticatory function in oral environment may fatigue the integrity of resin-tooth bonds, thereby permitting micro- or nanoleakage [20,21]. Other degradation promoting factors are residual solvent of the adhesive or insufficiently removed surface water [22]. Water was suggested to be incompletely removed and resulted in regions of incomplete polymerization and/or hydrogel formation making the hybridized adhesive–dentin interface more degradation sensitive. Clinically, marginal deterioration of resin composite remains problematic and forms the major factor that dramatically shorten the lifetime of composite-tooth bond [21].

Therefore, this research evaluate and compare the effect of water storage on the micro-shear bond strength of contemporary composite resins using three adhesives systems, **[etch-and-rinse]**, and **[self-etch] "one" & "two" step.**

2. Materials

The materials used in this study are shown in Table 1:

2.1. Methods

2.1.1. Specimen preparation

After obtaining signed written consent from each patient to use their own teeth in current research, ninety sound human third molar teeth were recently extracted in out-patient clinic of faculty of dentistry, Tanta University, and stored in 0.5% chloramine solution at 4 °C were used within 1 month after extraction. All the teeth were mounted in acrylic blocks (2 mm below cementoenamel junction) for ease of manipulation. For each tooth, a standardized box-shaped Class I cavity (4.5 × 4.5 mm) was prepared at the occlusal surface with the pulpal floor ending at mid-coronal dentin (depth 4 mm from cavity outline borders), using a high-speed hand piece with a cylindrical flat end carbide fissure bur (# 2, Dentsply Mailfere, Swiss) under water coolant [23].

The teeth were divided into *three equal groups* according *to type of adhesive* used (thirty teeth each):

- **Group I**: A two-step etch-and-rinse (total etch) adhesive *"Single bond 3M, EPSE, USA"*
- **Group II**: A two-step self-etch adhesive *"Clearfil SE bond, Kuraray, Japan"*.
- **Group III**: A one-step self-etch adhesive *"Futura bond NR,* Voco Cuxhaven, Germany".

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