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Effect of thermocycling on the micro-shear bond strength of solvent free and solvent containing self-etch adhesives to dentin

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Abstract

The aim was to investigate the effect of thermocycling on the microshear bond strength of one solvent free self etch adhesive system, Bond-1SF, and two solvent containing self-etch adhesives, Futurabond DC and Adper Easy One.

Materials and methods: Sixty caries free third molars were used to prepare specimens of dentin surfaces. The adhesives were applied on dentin surfaces according to the manufacturer's instructions then Grandio-SO Composite resin was condensed through a polyethylene tube with a one mm internal diameter and height attached firmly to dentin surfaces and light cured. The bonded specimens were stored in distilled water at 37 °C for 24 h before being tested. Half of the bonded specimens were tested for microshear bond strength without thermocycling and the other half were thermocycled in water baths held at 5°c and 55°c with a dwell time of 1 min each for 500 cycles prior to testing. The micro shears bond strength before and after thermocycling was calculated and statistically analyzed to show the interaction between different materials.

Results: Without thermocycling, the bond strength of Futurabond DC and Adper Easy, were 22.524 MPa and 23.397 MPa respectively, while Bond-1 SF solvent free one step at lowered mean value 22.284 MPa and the difference was not statistically significant ($p > 0.05$). After thermocycling the bond strength of Futurabond DC and Adper Easy were 14.904 MPa, 22.713 MPa respectively, while Bond-1 SF solvent free one step self etch adhesive had 18.318 MPa and the differences were statistically significant ($p > 0.05$).

Conclusion: Thermocycling had a negative effect on the bonding of self etching adhesive systems to dentin and solvent free adhesive system has non-significant lower bond strength in relation to solvent containing adhesive systems.

Keywords: Self-etch adhesives; Solvent free; Thermocycling; Microshear bond strength

1. Introduction

Long term durability of bonds between adhesive resin systems and dentin is important for the longevity of bonded restorations. Self etching adhesives are widely employed, mainly because of their ease of use

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and low technique sensitive. However, the longevity of adhesive bonds is still an area of interest in adhesive dentistry. Bond durability of various dental adhesive systems has been the subject of several studies [1].

The bond strength of adhesive systems declined over time but the bonding interface using self etching primers was relatively stable compared to the wet bonding system [2]. In addition to the effect of the adhesive system, thermocycling can decrease bond durability [3,4].

Several dentin bonding adhesives have been developed for the restoration of lost tooth structure [5]. The major goal of using dentin bonding agents is to enhance the bonding strength between the resin and the tooth structure, increase the retention of restoration, and reduce the micro-leakage across dentin-resin interface [6]. Bonding to dentin has been less predictable because of the wet tubular ultra-structure and organic composition of the dentin substrate [7].

The introductions of the total etch technique and recent developments in the chemistry of dentin adhesives have made resin based composite restorative materials nearly free of micro-leakage with bond strengths approaching those of enamel bonding [8–11].

Current dentin adhesives employ two different means to achieve the goal of micro-mechanical retention between resin and dentin. The first method removes the smear layer completely and demineralized the subsurface intact dentin via etching with acids. Following rinsing, a multi-step application of a primer and an adhesive bond is applied to the conditioned substrate to complete the bonding protocol. The second method used the smear layer as a bonding substrate, so, there are two types of simplified adhesives that are applied to the smear layer, one is a self-etching primer that includes two steps; the acidic primer is applied without rinsing then a layer of adhesive bond resin is applied, while the other type is more simplified, one step self-etching adhesive system that includes a single application to the tooth structure [12].

With these systems, etching and priming of dentin surface occurs simultaneously by infiltrating the smear covered dentin with acidic resins, so, critical procedures like rinsing of the etchant and priming of the hydrated collagen fibers are eliminated and they are considering to be less technique sensitive compared to systems utilizing separate acid conditioning and rinsing steps. However, it is still unclear whether these materials can produce strong and durable bonds [13]. Also inadequate polymerization of resins or defects within the inter-diffusion zone or hybrid layer could occur due to diffusion gradients created by dentinal tissues, moisture contents, residual solvents, or phase separation of monomers [14,15].

Thermal cycling simulates the introduction of hot and cold extremes in the oral cavity and shows the relationship of the linear coefficient of thermal expansion between tooth and restorative materials. Thermal cycling stresses the bond between resin and the tooth and depending on the adhesive system, may affect the bond strength [16–18].

Different solvents present in primer components of adhesive systems are responsible for either carrying excess water out or infiltrating resin monomers into demineralized collagen matrix. On the other hands, solvents improving substrate wetting, aiding to impede the collagen fibrils collapse or to stiffen them [19].

However, as water evaporation from the adhesive, the monomer to water ratio increases and lowers the vapor pressure of water, thus reducing the ability of water and solvents to evaporate from the adhesive [20].

It is likely that, after solvent having completed their function, it must be eliminated because it has been demonstrated that residual solvent can lead to deterioration of the adhesive interface between tooth structure and composite resin by interfering with resin polymerization [21,22]. Also, residual water and solvent will be trapped within the adhesive resin upon curing and this may compromise the overall bonding and the mechanical properties of the cured resin by interfering with polymerization [23,24]. Consequently, removal of solvent and water is of prime importance for the integrity and durability of resin dentin bond.

Recently a new solvent free, self-etching and single bottled adhesive system has been introduced in dentistry during restoring by resin composite. This adhesive type used a proprietary formula that eliminates the need for commonly used solvents such as acetone, alcohol or water and not only reduces the number of application steps but also removes the ambiguity of air–volatizing residual solvents prior to light curing of bonding agents and no residual solvents present to reduce bond strengths and disrupt the hermetic seal needed to eliminate water transportation from the underlying dentin structure [25].

The aim of the present study was to investigate the effectiveness of thermocycling on the microshear bond strength of one solvent free adhesive system (Bond-1 SF) and two solvent containing adhesive systems (Futurabond DC. and Adper Easy One) to dentin.