Effect of air drying time and distance of self-etch adhesives on dentin bond strength.

Thesis submitted to the Faculty of Dentistry

Ain Shams University in Partial Fulfillment of the

Requirements for Master Degree in Operative Dentistry.

By

Mona Mohamed El-Sayed Arida

B.D.S. (2008)

Faculty of oral and dental medicine

Cairo University

2015

Supervision

Dr. Mokhtar Nagy Ibrahim

Professor of operative dentistry

Faculty of Dentistry

Ain Shams University

Dr. Dina Ahmed El-Refai

Lecturer of Dental Biomaterials

Faculty of Dentistry

Ain Shams University

Dedication

To my **parents**, words can never express my thanks and appreciation for the great effort and support you give me every day.

To my **husband**, the one who is always there for me.

To my little angels **Farida** and **Alia**, you enlighten my heart with joy.

Acknowledgment

First of all, I'm deeply thankful to **ALLAH** to whom I relate any success I have achieved in my life.

I would like to express my deepest thanks and grateful appreciation to my supervisors:

Dr. Mokhtar Nagy Ibrahim, professor of operative Dentistry, Faculty of Dentistry, Ain Shams University, for his valuable advice, support, patience and encouragement.

Dr. Dina Ahmed El-Refai, Lecturer of Dental Biomaterials Faculty of Dentistry, Ain Shams University, for her generous help, support, guidance and continuous follow up from the beginning to the end of this thesis .

I would also like to sincerely thank Sara Ali, Shaza Mokhles and Rahma Elsherbiny for their great help and support.

Last but not least, I would like to thank all my friends and colleagues for their help and encouragement

List of contents

List of tables

List of figures

The revolution in direct esthetic restorations in conjunction with the recent adhesive techniques have made it easier to achieve a more naturally appearing restoration of dental hard tissues. (1)

Patient demand for esthetic restorations has generated an interest in the advancement of adhesive dentistry. (2) Although adhesion to enamel is predictable in contemporary restorative dentistry, an adequate bond to dentin is more difficult to achieve. This is due to the biologic characteristics of dentin, mainly, its high organic content, its tubular structure with the presence of odontoblastic processes, the continuous moist condition due to the presence of dentinal fluid, intratubular pressure, permeability of the dentin and the presence of a smear layer formed immediately after cavity preparation.(3)

Bonding to dentin is not only affected by the amount of resin that diffuses into the collagen layer but also by the quality of the bonding resin after polymerization. (4)

Depending on the basic adhesion strategy, three mechanisms of adhesion: total etch (etch and rinse), self-etch and glass ionomer are currently in use with modern adhesive systems. The drawbacks of the total-etch system are the risk of over-etching dentin, requiring a postconditioning rinse phase, sensitivity to an over-dry or over-wet surface and the involvement of multiple steps.(3)

Self-etching adhesive systems aim to reduce the operative time by reducing the number of steps during application, thereby minimizing the technique sensitivity and thus the risk of making errors. These systems are

based on nonrinse, acidic monomers that simultaneously condition and prime the dentin. The simultaneous etching and diffusion of monomers through the smear layer and the underlying dentin result in resin-infiltrated dentin, known as the hybrid layer. One-step self-etching adhesives (all-in-one adhesives) combines etching, priming and bonding, thus containing acidic functional monomers, hydrophilic and hydrophobic monomers, water and organic solvents into a single solution. In two-step self-etch systems, the acidic primers are placed in a separate bottle and are applied prior to the adhesive. [5]

In adhesives; water, ethanol and acetone are the most commonly used solvents. Water is an essential solvent of one-step self-etch adhesives, which allows them to generate the hydrogen ions required for effective dissolution and demineralization of tooth substrates.[6] Concerning ethanol, because of its volatile characteristics, it helps to displace water from the dentinal surface and the moist collagen network.[7].

Ideally, all solvents should be completely removed from the dentin surface prior to polymerization. One clinical approach for obtaining stable bonding to dentin and relatively higher bond strengths is to employ warm air-drying of the adhesives. [8, 9]

Air-blowing is important to ensure a good distribution of the adhesive on the dentin surface and to eliminate substances that could influence polymerization. [10]

Incomplete evaporation of the solvent results in dilution, poor polymerization or phase separation of the resin components. After light

curing of the adhesives, residual water or solvents may become pathways for water movements within the hybrid or resin layers, increasing the permeability of the resin dentin interfaces and their subsequent susceptibility to degradation via resin hydrolysis.[11] Excessive air drying may cause excessive air thinning of the adhesive, and this might partially negate its effectiveness. Additionally, it is possible that remaining adhesive becomes saturated with oxygen that could in turn inhibit its polymerization. Thus, excessive air-drying might lead to an extremely thin adhesive layer, that is not preferred, as it could act less as ‘‘stress breaker’’ at the adhesive interface. [12]

Recent studies have shown that bond strength and other mechanical properties of the adhesives may be affected by different solvent evaporation periods. [13, 14]

From this point of view, it is of prime importance to study the effect of different air drying durations as well as different air drying distances from dentin surface on shear bond strength of resin composite to dentin using self etch adhesives.

I. Development of self etch adhesives

Van Meerbeek et.al, 2010 ;[15] presented the general characteristics of self-etch adhesives. Unlike etch-and-rinse adhesives, self-etch adhesives do not require a separate etching step, as they contain acidic monomers that simultaneously 'condition' and 'prime' the dental substrate. Consequently, this approach has been claimed to be more user-friendly (shorter application time, less steps) and less technique-sensitive (no wet-bonding, simple drying), thereby resulting in a reliable clinical performance, though this appeared very product-dependent. Another important clinical benefit of self-etch adhesives is the absence of, or at least lower incidence of post-operative sensitivity experienced by patients as compared to that associated with etch-and-rinse adhesives. This should, to a great extent, be attributed to their less aggressiveness and thus more superficial interaction with dentin compared to phosphoric acid etching, leaving dentinal tubules largely obstructed with smear layer. All these favorable key-features have lead to the steadily growing popularity of self-etch adhesives in today's dental practices.

Self-etch adhesives are present as either 'two-step' or 'one- step' adhesives, depending on whether a self-etching primer and (mostly solvent-free) adhesive resin are separately provided or are combined into one single solution. One-step adhesives can be further subdivided into either 'two-component' or 'single-component' one-step self-etch adhesives. By separating active ingredients like the functional monomer from water, two-component self-etch adhesives theoretically posses a longer shelf life, although additional and adequate mixing of both components is needed. The single-component one- step adhesives can be considered as the only true

'one-bottle' or 'all-in-one' adhesives, as they combine 'conditioning', 'priming' and 'application of the adhesive resin' and do not require mixing.

Depending upon the acid dissociation constants (pKa values), the etching aggressiveness of self-etch adhesive systems can also be classified into: "strong" (pH<1), "intermediately strong" (pH≈1.5), "mild" (pH≈2) and "ultra-mild" (pH≥2.5).[16] The more aggressive systems, the deeper demineralization of the tooth substrate occurs resembling that of phosphoric acid-etching treatment. At enamel, "strong" self-etching shows good bonding performance, while the bonding effectiveness of "mild" self-etching on enamel is not efficient and can be improved by prior phosphoric acid etching. [17]

On the other hand, concerning dentin, "strong self-etching" dissolves nearly all smear layer, but does not remove the dissolved calcium phosphates. These embedded calcium phosphates seem to have low hydrolytic stability, with non-stable chemical interaction with the exposed collagen, thereby weakening the interfacial integrity, especially in a long-term. "Intermediate strong" self-etching shows a transition between "strong" and "mild" etching characteristics of the hybrid layer formed. It has typically a hybrid layer with demineralized top layer and partially demineralized base. "Mild" self-etching partially removes the smear layer, forming a thin hybrid layer. It has the great advantage of leaving substantial amount of hydroxyapatite-crystals around collagen fibrils that establish chemical bond with specific carboxylic or Phosphate groups of functional monomers. The"ultramild" self-etching can only expose superficially dentin collagen, producing a nanometer interaction zone. [17]

The bonding mechanism of self-etch adhesive systems has been intensely investigated and two-fold bonding mechanisms; micro-mechanical interlocking and chemical bonding were described, which seems to be advantageous in terms of restoration durability. The micro-mechanical bonding contributes to provide strength against mechanical stress, while the chemical interaction reduces hydrolytic degradation, keeping the marginal sealing of restorations for a longer period. (18)

In order to enable (self-) etching, all self-etch adhesives contain water as an ionizing medium. The only exceptions are some commercially available water-free self-etch adhesives. They however require a more technique-sensitive 'wet-bonding' application technique, like required for acetone-based etch-and-rinse adhesives. (15)

Adhesive resin/dentin bond strength plays an important role in determining the clinical success of dental restorations. Whereas long-term clinical trials are the ultimate tests to evaluate the longevity of dental restoration, they are difficult to perform because they take a long time. In addition, clinical trials cannot determine the true reason for failure given the simultaneous impact of diverse stresses on restorations within the oral cavity. Therefore, laboratory bond strength tests are commonly used to compare adhesive systems. (19)

Self-etching one-component adhesive systems have been shown to contain a higher concentration of acid derivatives, methacrylated phosphoric acid esters, water, and organic solvents than conventional bonding agents to simultaneously etch and infiltrate the dentin surface in one step. Due to their hydrophilic nature, these adhesives may act as permeable membranes,