EFFECT OF LIGHT CURING DISTANCE ON WATER SORPTION AND WATER SOLUBILITY OF DIFFERENT SELF ETCH ADHESIVES

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There has been an increased use of metal-free indirect ceramic restorations; which made resin-based composite luting agents become an essential component of the restorative practice.

Self-etch adhesive systems are aqueous mixtures of acidic functional monomers, usually phosphoric acid esters with a pH value higher than that of phosphoric acid gels. Self-etch adhesives have been introduced in order to properly infiltrate hard tooth tissue, specifically dentin. It combines etch, prime and bond in a single solution, which is very hydrophilic given the water solvent and 2-hydroxyethyl methacrylate (HEMA) present in most([1]).

The function of water is to ionize acidic monomers while that of HEMA is to enhance wetting of dentin and keep hydrophilic and hydrophobic monomers stable in solution([1]).

Indirect metal free restorations and fiber posts, with exception of porcelain veneers, should be bonded with self or dual cure composite luting agents as opposed to light cured only composite luting agents because of the increased thickness of the restoration & the location of the margins relative to the light curing device, a light-cured only luting agent might not fully polymerize and hence compromise the mechanical properties of the restoration([2]).

Most composite luting agents require that the tooth surface be treated with a dental adhesive prior to luting of the restoration, although some have self-adhesive properties. The use of self- and dual-cure composite luting agents with simplified adhesives has been shown to be problematic, as residual acidic monomers present at the oxygen inhibited layer of the adhesive react with the initiator component (aromatic tertiary amine) in the dual-cure composite luting agent,

compromising its polymerization. Similar compatibility problems have been reported when simplified adhesives are used with self- and dual-cure composite cores and restorations[3].

The degree of conversion affects the physical properties and chemical stability of adhesive materials directly. The higher the degree of conversion, the better the surface properties, Such as hardness, modulus of elasticity, resistance to fracture and diametral tensile strength. However, these mechanical properties depend on the type of polymeric chain and density of cross-links formed during the polymerization process[5]).

When a solvent enters the polymer network, it causes an expansion of the structure, facilitates extraction of monomers that did not react and promotes the dissolution of linear polymer chains. This expansion is facilitated when the density of cross-links is low. Thus, polymers with a high density of cross-links are more resistant to degradation due to the greater limitation of space and possible paths for the diffusion of permeants in the polymer structure[4]. Such water sorption may contribute to the failure of adhesive-dentin bonds[5]).

All in one adhesives " self-etch adhesives " have shown higher water sorption compared with three-step etch-and-rinse and two step etch-and-rinse adhesives a positive association between HEMA content and adhesive degradation, and an association between hydrophilicity of adhesives and water sorption and solubility have been reported. Ideally, polymer networks should be insoluble materials with relatively high chemical and thermal stability. However, most of the monomers used in dental resin materials can absorb water and chemicals from the

environment, and release components into the surrounding environment.([6])

Moreover; it was found that the movement of water from hydrated dentin may cause the formation of water-filled channels within the polymer matrices of contemporary hydrophilic dentin adhesives. Accordingly, these water-filled channels may accelerate elution of unreacted monomers from polymerized resins, as well as promote weakening of the polymers by plasticization. Thus, both water sorption and solubility would lead to a variety of chemical and physical processes that may result in deleterious effects on the structure and function of dental polymers, including their retentive capacity in adhesive dentistry([7]).

Accordingly, studying the effect of light curing at two different light curing distances on water sorption and solubility of various commercial light cured and dual-cured self-etching adhesives might be of value([7]).

In this study it was hypothesized that Light curing distance has an effect on water sorption & solubility, and level of water sorption & solubility differs between light & dual cured adhesives, also there is individual difference in water sorption and solubility between different one step self-etching adhesives.

One step self-etch adhesives were introduced in order to overcome some of the difficulties that were found in the earlier conventional etch and rinse adhesives, were they are simplified so as to be more dentists friendly. They also showed less post-operative hypersensitivity and less technique sensitivity. Another advantage is that they tend to infiltrate simultaneously with the self-etch process which showed less Nanoleakage over time.([8])

Simplification of one step self-etch adhesives lead to increasing the hydrophilicity of the adhesive solution owing to the increase of the hydrophilic acidic monomer concentration which lead to compromised resin – dentin bond strength.[(8)(9)] there is another type of one step self-etch adhesives called the "Universal or Multi-mode adhesives", they can be applied on etched or un-etched enamel and dentin.([8])

These simplified adhesive systems have a major disadvantage, where they are affected by water sorption and water solubility because of their Composition. The majority of one step self-etch adhesives contain ionic resin monomers with acidic phosphate or carboxylic functional groups, hydrophilic monomers, hydrophobic monomers, water & organic solvents all in a single bottle, thus, these adhesives are highly hydrophilic. [(11)]

The hydrophilicity of these adhesive solutions depends on the number of acidic and highly polar functional groups substituted with the methacrylate monomers. In some studies it was shown that the hydrophilicity of these adhesives is related to water sorption into the adhesive polymers. were the more hydrophilic the adhesives are, the more water their polymers absorb, this Water absorption into the adhesive polymers results in polymer swelling, plasticizing, a reduction

in glass transition temperature and a weakening of the polymer network([11]).

In a study to test the relation between water sorption and hydrophilicity of polymer, Hoy's solubility parameter was used to rank the hydrophilicity of the polymers; Hoys solubility parameters are various parameters used to measure, understand the behavior of solvents, to identify them, to predict its longevity and provide estimates of the relative contribution of dispersive forces (δd), polar forces (δp), hydrogen bonding forces (δh), to total cohesive forces (δt) (equivalent to Hildebrand's δ)[(10)(11)].

since it is difficult to correlate between the adhesives hydrophilicity and water sorption because of the unknown exact composition of commercially available adhesive resin blends, in this study multiple experimental adhesives and primers were used with exact known chemical composition and relative concentrations, and calculated hoy's solubility parameters of each constituent, the results of the study showed significantly high correlation between water sorption and water solubility of the tested experimental adhesives and primers and accordingly correlation between adhesives' hydrophilicity and there expected water sorption and water solubility.([11])

Hydroxyethyle methacrylate **(HEMA)**, which is a hydrophilic monomer, is frequently added in various concentrations to one-step self-etch adhesives because of its positive influence on adhesion to dentin, the miscibility of hydrophobic and hydrophilic components in the adhesive blend and prevention of phase separation. However, HEMA (*i.e.* poly-HEMA) attracts water even after polymerization, where, it was stated

that HEMA's presence increases water sorption after polymerization of the primer polymers.[11] Therefore, higher concentrations of HEMA might compromise the long-term stability of resin-dentin interface([12]).

These adhesive polymers act as semi-permeable membranes, permitting water movement across the adhesive layer even after adhesive polymerization, leading to deterioration in their mechanical properties. Thus, the amount of water sorption in a one-step self-etch adhesive might contribute to a degradation acceleration of the adhesive interface to dentin after long-term water storage. There have been few studies on the influence of amount of water sorption in one-step Self-etch adhesives on the durability of the resin-dentin bond. As such, the relationship between the bonding durability of one-step self-etch adhesives to dentin and water sorption is still unclear.[12]

As the water permeability of resins is directly correlated with both hydrophilicity and extent of polymerization of dentin bonding agents, there is a direct correlation between hydrophilicity of adhesive blends and their degree of conversion (DC). However, since the exact composition of commercially available resin blends are never disclosed by manufactures, previous reports failed to relate the DC of each adhesive to its hydrophilicity([13]).

A study that was conducted to evaluate the relation between Degree of Polymerization of experimentally prepared five dentin bonding agents of known chemical composition, concentration and hoy's solubility parameters, with their solvent content and hydrophilicity. Results of this study supported the idea that degree of polymerization (monomer-polymer conversion) of comonomer blends is correlated with the hydrophilicity of its solvent content([13]). In an another study to