EVALUATION OF RESIN/DENTIN INTERFACE AND ADAPTATION OF COMPOSITE RESTORATION USING DIFFERENT SELF-ETCHING ADHESIVES

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Today, with the rapid growth in the field of adhesive dentistry, one-step self-etching adhesives are considered, by majority of dental practitioners, the most popular adhesives in use. Due to their clinical steps simplicity, one-step self-etching adhesives are less technique sensitive, compared to the etch-and-rinse ones. This clinical popularity raised the need for laboratory evaluation and durability assessment for such adhesives.

One of the major advantages in the one-step self-etching adhesives is the elimination of the rinsing step by combining the etching and priming steps. This decreases the number of clinical steps, shorten the application time and therefore reduces the possibility of errors.[1-4] The ability of the monomer to simultaneously etch and infiltrate dentin, reduces the possibility of discrepancies between the two processes [4] and consequently, eliminates the presence of unprotected collagen fibers.[2,5,6]

The high pH of the one-step self-etching adhesives relative to that of phosphoric acid etchants is achieved by incorporating aqueous solutions of acidic monomers in the adhesives.[7] These acidic monomers need water as a reaction medium in order to ionize and act. Monomer dilution and reduction in degree of polymerization are the consequences of the presence of remaining water, which does not completely evaporate during the air-drying step.[8,9] Addition of hydrophilic HEMA monomer is mandatory to increase the solubility of these acidic monomers in water and to increase the strength of the cross-linking of the formed polymer matrix.[10] Higher concentrations of HEMA result in attraction of water on dentin which decreases the initial bond strength.[11]

The increased permeability of the one-step self-etching adhesives due to the increase in the hydrophilic monomers is one of the problems encountered in these adhesives. This causes the one-step self-etching adhesive to act as a permeable membrane after polymerization.[12] Although the polymerized adhesive appears intact, water could move from the underlying dentin through polymerized adhesive where it becomes entrapped.[12,13] Due to the water diffusion, the unreacted components leach out.[14] leading to the formation of water filled voids within the adhesive, forming a permeable adhesive interface.

Adhesives' behaviors vary from one type to another, but all of them deteriorate by time for a variety of reasons. The result of this deterioration is microleakage, gap formation and decrease in bond strength. It was reported that bond strength alone was an inadequate indicator of the efficiency of adhesive restorative systems because good bond strength values were found in areas with gaps.[15] These areas are prone to microleakage and consequent restoration failure, which emphasizes the importance of microleakage and gap assessment. Accordingly, evaluating the dentinal microleakage of the one-step self-etching adhesives with different aggressiveness at various storage times could be of value.

Microleakage and gap assessment of self-etch adhesives

The dream of making gap-free restorations made many scientists carry out research projects on the field of adhesive dentistry. Microleakage is a method to evaluate the presence or absence of micro-gaps at resin/tooth interface. The target of this evaluation methodology is to improve the adhesives' performance.

Zivković, in 2000[16] assessed the marginal sealing ability of resin composite to dentin using seven different adhesive systems. In this study, two types of class V cavities were prepared on both buccal and lingual surfaces of human premolar teeth. All the cavities were prepared with surrounding margins in dentin. Marginal sealing was evaluated using silver nitrate. Their results showed that among the adhesives tested; the 4-step etch-and-rinse adhesives performed well at the composite/cavity wall interface. Unfortunately complete elimination of microleakage was not performed, even with the use of adhesive with its corresponding resin composite.

Mathew, et al. in 2001[17] studied the effect of bonding agent as a determining factor of marginal leakage of dental composites when subjected to thermal cycling. Silver staining was employed to detect leakage in Class II restorations. Scanning electron microscope and optical microscope results proved that bonding agents improved adhesion. Further reduction of microleakage accompanied the application of a second coat of bonding agent. They proved that thermal cycling provided appropriate representation of the adhesive behavior during in vitro studies.

Manhart, et al. in 2001[18] studied the microleakage and marginal quality of Class V restorations. Standardized cavities of 4mm diameter and 2 mm depth were performed in ninety extracted human molars and the teeth were divided into nine groups according to type of adhesive used. Nine 2 step etch-and-rinse adhesive systems were applied to teeth using a wet bonding procedure. Teeth were subjected to thermocycling after 24h storing, stained with methylene blue, sectioned and leakage was evaluated. Epoxy replicas were made for margin analysis using SEM. The results showed that significant differences were present between enamel and dentin margins when using the etch-and-rinse adhesives.

Santini, et al. in 2001[19] studied the effect of composite resin placement techniques on the microleakage of two self-etching adhesives. Cavities were prepared in the buccal and lingual surfaces of 60 extracted human molars and premolars, with the preparation margins located in enamel and dentin. The cavities were treated with two 1-step self-etching adhesives, while 2-step etch-and-rinse adhesive served as control. Microleakage was assessed using a red marker, while the micromorphology of the interface was evaluated using SEM. The results showed that enamel margin did not show microleakage. On the other hand, gingival margin, which was located in dentin, showed a statistical non-significant microleakage between the tested adhesives. Furthermore, there is no statistical difference between both placement techniques (bulk versus incremental technique). Predominant cohesive failure in resin was shown in the microleakage interface area. The self-etching adhesives created a shallow depth of etching with less abundant resin tags, compared to the control etch-and-rinse adhesive. This type of adhesive system did not eliminate the microleakage at the gingival margin.

Pradelle, et al. in 2001[20] assessed the microleakage at the enamel-dentin/ composite interface of 4 dentin bonding systems. Two 2-step etch-and-rinse adhesives, a 2-step self-etching adhesive and a 1-step self-etching adhesive were used. Class V cavities were prepared on the buccal and lingual surfaces at the cemento-enamel junction of ninety extracted human teeth. A dye solution was used to assess the microleakage. Their results showed that the 2-step etch-and-rinse adhesives performed significantly better than the self-etching priming system.

Irie, et al. in 2002[21] studied the marginal gap formation of light activated restorative material due to the effect of immediate setting shrinkage and bond strength. After light-activation, the marginal gap, shrinkage and bonding to enamel and dentin were measured for three different restorative materials. Their results indicated that in the restorative materials investigated, there was a highly significant correlation between marginal gap in tooth cavity and in the Teflon cavity. On the other hand no statistical significant relationship was observed between the marginal gap in the tooth cavity with both the immediate diametral shrinkage-strain and shear bond strength to enamel and dentin.

Cardoso, et al. in 2002[22] evaluated the microleakage of four simplified adhesive systems when subjected to thermal and mechanical stresses. Forty slot preparations were prepared in sound human molars with the gingival margins placed below cement-enamel junction. A 1-