Effect of Light Cure vs Dual Cure Self-Etch Adhesives on Shear Bond Strength of Bulk Fill Resin Based Composite Material to Dentin

Thesis

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I wish to dedicate this work to

My Great Parents,

My Lovely Supporting Wife,

My Lovely Brother and Sister,

My Father and Mother in Law,

And My Little Baby Boy to be.

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Abbreviation	refer to
AD- concept	Adhesion decalcification concept
10-MDP	10-Methacryloyloxydecyl dihydrogen phosphate
BisGMA	Bisphenol A Diglycidyl Ether Dimethacrylate
HEMA	2-Hydroxyethyl methacrylate
TEGDMA	Triethylene Glycol Dimethacrylate
HEDMA	2-Hydroxyethyl dimethacrylate
UDMA	Urethane dimethacrylate
BHT	Butylated hydroxytoluene
SPSS	statistical package for the social science
Min	Minutes
Mm	Millimeters
MPa	Mega Pascal
SBU	Single bond universal
SBU DCA	Single Bond Universal DCA
FbU	Futurabond universal
FM+	Futurabond M+
FM+ DCA	Futurabond M+DCA
ABU	All Bond Universal
mW	Milliwatt
Cm^2	centimeter squared

Resin based composite materials were first introduced more than fifty years ago as an alternative material to dental amalgam due to increased patient esthetic demands . Besides esthetic improvement, there is also environmental and hygienic concerns with dental amalgam that led to the increased use of resin based composite materials.(1)

Since introduction of light cured composite material, dentists had to place them in increments for several reasons including the curing depth of composite and to minimize the polymerization shrinkage and the following shrinkage stresses. Incremental packing of composite allows for better stress management and more adaptation of composite but it is also time consuming and technique sensitive.(2)

Bulk-fill resin composites were introduced to decrease the number of increments required to fill a cavity in comparison to the conventional incremental filling technique. Bulk-fill resin composite can be placed in thick increments up to 4-5mm per increment. The use of bulk-fill composite saves time and decreases clinical steps.(3)

The main use of adhesives is for retention of composite. They also prevent leakage around restoration margins in addition to withstanding shrinkage stresses developed during polymerization of composite.(4)Adhesive restorative dentistry was first originated when Buonocore tried to bond resin to acid etched enamel. He used phosphoric acid for enamel etching.(5)

Dental adhesives can be classified into three main groups according to the adhesion strategy: Etch and rinse, self-etch and glass ionomer adhesives. The etch and rinse adhesive system involves the use of phosphoric acid etch, primer and adhesive. Self-etch adhesives were developed to reduce the number of steps and therefore become more user friendly and less

technique sensitive. It can be used in two steps or in a single step application.[6]

With the increased success of indirect ceramic restorations, the demand for a reliable bond between the adhesive system and the tooth substrate became mandatory. Simplified adhesives (two-step etch and rinse and one-step self-etch) showed an incompatibility problem when used with self-cured or dual-cured resin composites or resin cements. Residual acidic monomers in the underlying oxygen inhibited layer may inactivate the initiator (aromatic tertiary amine) of the dual cure resin composites or cements impairing their polymerization. Manufacturers' tend to solve this problem by adding a chemical initiator to the adhesive such as aryl sulfinic acid salts, organoboron compounds and babituric acid chloride. These chemical co-initiators react with the acidic resin monomers releasing either phenyl or benzenesulfonyl free radicals that can initiate the reaction of dual cured resin composites or cements.[7]

Multimode or universal adhesives are the latest generation in the market which give the operator the choice of which adhesive technique to use either etch and rinse or self-etch.[8] The aim of this study is to evaluate the effect of different self-etch adhesives on shear bond strength of resin based composite materials to dentin.

Nowadays, resin based composite restorations became the most popular restoration used in restorative dentistry. The need for faster and simpler clinical restorative procedures is increasing. The decrease in the clinical application steps and procedure time is demanded by the dentists and the patients especially in pediatric dentistry. So There are continuous trials for improving the restorative procedure and make it faster.[9]

1. Introduction to Dental adhesives:

The beginning of successful adhesive dentistry was first reported when Buonocore tried to bond resin to acid etched enamel. He used phosphoric acid as an etchant to create porous enamel surface that will be infiltrated by resin making a strong micromechanical bond.[5]Adhesives can be classified into three main groups according to the adhesion strategy: Etch and rinse, self-etch and glass ionomer adhesives. Irrespective of the adhesive system used, Adhesives generally composed of resin monomers. There are two types of monomers: hydrophilic functional monomer and hydrophobic cross-linkers. The former is to enhance the wettability of the adhesive and the latter provides strength for the adhesive. Adhesive components also includes initiators, inhibitors, solvents and some adhesives may contain fillers.[4] Whatever the adhesive system used, there is a general mechanism of adhesion to tooth dental substrate where calcium phosphate ions are replaced by resin monomers that infiltrate the created micro porosities resulting in what is called the hybrid layer. This provides a strong micromechanical interlocking resulting in a good bonding.[6]

2. Etch and rinse adhesives:

Etch and rinse adhesive systems are often considered as the gold standard for adhesion to tooth structure. They usually include the three step application of acid etchant followed by the primer application then the bonding agent. The latter two steps can be combined into a single step but still needs a separate etching step and this is the simplified version of the etch and rinse adhesive system.[5,10]

The authors believed that the good results obtained when using conventional acid etching with phosphoric acid are due to the particular morphology of the interface after etching of enamel with phosphoric acid in concentrations in the range of 34-37%. The resin infiltration is extensive and the transition from resin to sound enamel extends over a number of microns. This interface may be more resistant to crack propagation than that produced with self-etch adhesives. [11]

Enamel etching with phosphoric acid will lead to removal of the smear layer and creates a porous surface. This porous surface can be penetrated by a low viscosity bonding agent that after polymerization will bond to the enamel surface by micromechanical interlocking. Two types of resin tags interlock with the etched enamel surface, macro-tags and micro-tags. Macro-tags are formed within the space surrounding the enamel prisms while micro-tags are formed as a result of resin infiltration within the tiny etch-pits at the cores of etched enamel prisms. The latter are thought to contribute to retention to enamel.[6,10]

Dentine etching removes the smear layer and exposes a micro-porous collagen network that is nearly totally deprived of hydroxyapatite. This leads to formation of a very permeable layer that allows the infiltration of hydrophilic adhesives into the exposed collagen and formation of resin tags

in the tubules. Resin should infiltrate the demineralized matrix to the same depth of demineralization to form a hybridized biocomposite of collagen fibrils reinforced by resin. Nakabayashi and his group were the first to demonstrate the formation of this hybridized biocomposite when resin infiltrate into acid etched dentin and names this new structure as hybrid layer.[6,10,12]

The major disadvantage of the etch and rinse approach is that infiltration of the collagen network by resin monomer is not ideal which leads to voids within the hybrid layer that became a pathway for enzymatic degradation of the hybrid layer and this is defined as nano-leakage. Excessive etching of dentin leads to incomplete impregnation of the collagen fibers at the base of the demineralized dentin by the resin which leads to weak bonding. Also, collagen collapse may occur during drying after acid etching and moisture control.[13] These drawbacks of the etch and rinse system leads to the development of the self-etch adhesive system to solve these problems.[10]

3. Self-etch adhesives:

With the development of dental adhesives, the demands for a simpler bonding technique increase. So self-etch adhesives were introduced.[14] In comparison with etch and rinse adhesives, self-etch adhesives don't require a separate etching step as they contain specific acidic functional monomers that can etch and prime the tooth substrate. This makes them more user friendly as they need fewer application steps and thus less time.[14-15]

The self-etching primer and the bonding resin contain a mixture of resin monomers, initiators and other components. Water is an essential ingredient in the composition of self-etch adhesives as they act as an ionizing