

Self-Etching adhesive – Role in esthetic dentistry

Running title: Self-etching adhesive

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ABSTRACT:

In today's era, numerous improvements in materials and procedures have been made for the aesthetics demands of the patients. The self-etching primer system consists of an etchant and primer distributed in a single unit which reduces the number of steps and chance of introduction of error, resulting in saving time for the clinician. It also causes a lesser amount of enamel calcification. The purpose of this article is to review the current knowledge on various dentin bonding agents, which emphasises on self etching primers. This article aims to bring the feasibility for the usage of self-etching primers in a clinical scenario.

Keywords: Self-etching primer, Enamel calcification, dentin bonding agents.

MAIN TEXT REVIEW

INTRODUCTION:

The method of self-etching technique was created approximately 20 years ago. In the modern society, aesthetics has become a major interest for every individual. Thus most of us desire for a perfect set of teeth. Therefore the advent of adhesive restorative materials has decreased the need for an extensive tooth preparation. The demand for esthetic dental materials has caused the improvement of many bonding systems to provide strong bonding to tooth structure⁽¹⁾.Dental adhesives are resin monomers that make the resin dentin substrate interaction achievable. Adhesive systems consist of monomers with both hydrophilic and hydrophobic groups.

HISTORY AND EVOLUTION:

- In 1949, Dr. Hagger, a Swiss chemist, enforced patent for the primary dental adhesive.
- In 1952, Mclean and Kramer postulate, "Sevriton Cavity Seal", which chemically bond to tooth structure.
- In 1954, Buonocore (Father of Adhesive Dentistry) conducted his first experiment on adhesion to enamel through acid etching and he focused on altering the enamel surface to obtain a bond with filling materials.
- Buonocore theorized that the etchant is employed for enamel adhesion, and by the late 1960s, he found that dentin bonding was possible.⁽²⁾
- Eick, in 1970s, using SEM found that the concept of smear layer that blocked adhesion to dentin, and simultaneously, total etch concept were introduced.
- By the 1980s, etch-and-rinse adhesive has gained widespread acceptability.
- Nakabayashi, in 1982, was the first to demonstrate true hybrid layer formation and founded that resin could infiltrate into acid-etched dentin to form a new structure composed of a resin-matrix reinforced by collagen fibrils.
- In the early 1990s, the advent of the three-step total-etch adhesive system constituted a revolution in adhesive dentistry.

- In the late 1990s two-step total-etch adhesive and two-step self-etch adhesive systems were introduced.

NEED FOR ADHESIVE DENTISTRY:

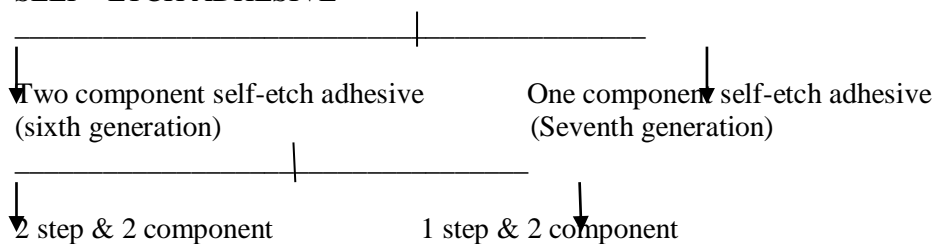
1. Reduces elimination of sound tooth structure, so maintenance of the tooth structure occurs.
2. Reduces micro leakage at the tooth restoration interface.
3. Decreases post-operative sensitivity, marginal staining and recurrent caries.
4. Adhesive restorations transmit and distribute higher functional stresses through the bonding interface to the tooth.
5. Minimises the chance of cuspal fracture and has the capacity to enhance the weakened tooth structure.
6. Adhesive approach has expanded the horizon of Esthetic Restorative Dentistry.

CLASSIFICATION:

- HISTORICAL STRATEGIES
 - First Generation (1965)
 - Second Generation (1978)
 - Third Generation (1984)
- CURRENT STRATEGIES
 - Etch & Rinse Adhesives
 - Three step - Etch & Rinse Adhesive (Fourth Generation)
 - Two step - Etch & Rinse Adhesive (Fifth Generation)
 - Self Etch Adhesives
 - Two component – Self Etch Adhesive (Sixth Generation)
 - Single component – One-step Self-Etch Adhesive (Seventh Generation)

SIXTH GENERATION - (Early 2000s):

SELF - ETCH ADHESIVE



SELF ETCH ADHESIVE:

They are described as “bonding systems” which dissolve the smear layer and create porosities underneath the dental substrates without a need for further conditioning agent (Eg: Phosphoric acid) to be applied in a single step. Less technique sensitive.

Based on the acidity of self-etch primer and adhesives, they are categorized as:

STRONG – pH<1

INTERMEDIATELY STRONG – pH~1.5

MILD – pH~2

ULTRAMILD –pH >2.5

STRONG SELF-ETCHING ADHESIVE at enamel shows good bonding performance⁽³⁾ and at dentin it dissolves all the smear layer, but does not remove dissolved calcium phosphates because they seem to have low hydrolytic stability and non-stable chemical interaction with exposed collagen therefore weakening the interfacing surface integrity.⁽⁴⁾

INTERMEDIATELY STRONG SELF-ETCHING ADHESIVE shows characteristics of hybrid layer formation, with top layer demineralized and partially demineralized base.⁽⁵⁾

MILD SELF-ETCHING ADHESIVE on enamel is not efficient and it is improved by prior phosphoric acid etching and partially removes the smear layer, forming a thin hybrid layer. It has a greatest

advantage of leaving hydroxyapatite-crystals which reveal chemical bond with specific carboxylic group of functional monomers.

ULTRA-MILD SELF-ETCHING ADHESIVE exposes only superficially dentin collagen, producing a nanometer interaction zone.⁽⁶⁾

Laboratory tests mainly used to evaluate bonding performance of adhesives are Micro-tensile⁽⁶⁾ and Micro-shear bond strength tests.

CHARACTERISTICS AND PROPERTIES:

Dental adhesives system has evolved to lessen the demand for decreased technique sensitivity, shorter clinical application time and less occurrence of post-operative sensitivity have made self-etch adhesives technique a promising approach.^(4,5)

Self-etch adhesive systems are categorized based on the range of clinical application steps:

TWO STEP: TWO COMPONENTS SELF ETCH ADHESIVE

They are also described as Non rinsing conditioners or self priming etchants. Include the usage of a hydrophilic etching primer combines with acidic monomers that concurrently etch and prime tooth substrate⁽⁸⁾ and after solvent evaporation, a layer of hydrophobic and bonding agent seal the dentin.⁽⁹⁾ Manipulation is easy and show appropriate bond strength to dentin but not to enamel. Etching and rinsing is not required. Primer is applied first and then the adhesive. Studies have shown that two step self etch adhesives provide superior bonding than one step self-etch adhesive system.⁽¹⁰⁾

MECHANISM OF ACTION:

These acidic primers contain phosphonated resin molecule that performs two functions:

- Etching and priming of enamel and dentin.
- Incorporating smear plugs into the resin tags.

STEPS INVOLVED:

STEP 1: Bottle 1- conditioner + primer application on the tooth surface.

(Wait for 10 seconds and no need to rinse the substrate)

STEP 2: Bottle 2- Adhesive application on the tooth surface.

STEP 3: Light cure.

BRAND NAMES:

Clearfil SE Bond (Kuraray, Japan)

Adhe SE (Ivoclar-Vivadent)

Optibond Solo Plus Self-etch (Kerr corp)

ONE STEP: TWO COMPONENT-SELF-ETCH ADHESIVE:

Consists of – Bottle 1 + Bottle 2

Bottle 1: conditioner + primer

Bottle 2: Adhesive resin

Both should be mixed prior to application on tooth surface

BRAND NAMES:

Xeno111 (Dentsply),

One up bond (Tokuyama),

Prompt L bond (3M ESPE).

ONE STEP: SINGLE COMPONENT – SELF-ETCH ADHESIVES (SEVENTH GENERATION):

Continuing the trend toward simplification, no-rinse, self-etching materials that include the essential steps of etching, priming and bonding into one solution have been introduced.

CONDITIONER + PRIMER + ADHESIVE ————— SINGLE BOTTLE

STEPS INVOLVED:^{*}

STEP 1: Dispense and apply on the tooth surface (no need to rinse the substrate).

STEP 2: Light cure.

MECHANISM OF ACTION:

In comparison to conventional adhesive systems that include an intermediate light-cured, low-viscosity bonding resin to join the composite restorative material to the primed dentin-enamel substrate, these one-step self-etch or 'all-in-one' adhesive technique contain acidic functional monomers such as hydrophilic and hydrophobic monomers, water and organic solvents dispersed in a single solution.^(5,11) These bonding agents are also indicated to be used as silane for glass ceramics and primer for metal alloys and polycrystalline ceramics.

BRAND NAMES:

AdheSE One F (Ivoclar Vivadent), Adper Easy One (3M ESPE)

PRIMER:

Primers are solutions containing hydrophilic monomers dissolved in a solvent which includes acetone, ethanol, or water. Such monomer exhibit hydrophilic properties via phosphate, carboxylic acid, alcohol, or ester functional groups. HEMA (2-hydroxyethyl methacrylate) is an extensively used primer monomer due to its excessive hydrophilicity and solvent like nature. If the primer has the capacity to both etch and prime, it is categorized as a SELF ETCHING PRIMER.

Representatives of those are:

- HEMA-phosphate, phenyl-P (2-[methacryloyloxydecyl] phenyl hydrogen phosphate)
- 10-MDP (10-methacryloyloxydecyl dihydrogen phosphate)
- 4-MET (4-methacryloyloxyethyl trimellitic acid)
- 4-META (4-methacryloyloxyethyl-1, 1'-undecanedicarboxylic acid).

MAIN ACTIONS:

- ✿ Primer unites the hydrophilic dentin to the hydrophobic adhesive resin.
- ✿ Promotes infiltration of demineralized peritubular and intertubular dentin.
- ✿ Increases wettability of the conditioned dentin surface.

BONDING MECHANISM TO ENAMEL AND DENTIN:

Bonding mechanisms of self-etch adhesive systems has been intensely analysed and two-fold bonding mechanisms which provide advantageous restoration durability.

1. Micro-mechanical interlocking
2. Chemical bonding

Micro-mechanical bonding contributes to offer strength against mechanical stress. Chemical interaction reduces hydrolytic degradation, retaining the marginal sealing of restorations for an extended period.^(5,7)

ENAMEL BONDING WITH SELF ETCH ADHESIVE:

Self-etching primers are acidic primer to demineralize enamel surfaces. Primers can be made acidic through grafting on carboxylic acid or a phosphate ester. Because of their higher pH, two-step self-etch adhesives bring about shallower enamel demineralization in comparison with that of phosphoric acid. Though, roughening of enamel to eliminate prism less enamel which improves the enamel-bonding ability of self-etch adhesives.

PRIMING OF DENTIN:

It is the procedure of applying primers to the etched/conditioned dentin surface to enhance the diffusion of the adhesive resin into moist and demineralized dentin.

MECHANISM OF DENTIN BONDING:

Primer displaces residual surface moisture. By use of bifunctional molecules, it wets and envelops the uncovered collagen fibrils. Providing sufficient amount of monomers into inter fibrillar channels. It transforms a hydrophilic substrate into a hydrophobic tissue state and increases the free surface energy.

CREATING ABRZ AT ENAMEL/DENTIN ADHESIVE INTERFACE:

Secondary caries is a major cause for failure of restorations. Acidic bacterial by products may penetrate not only to the bonding substrate, but also the tooth tissue at the periphery, causing marginal demineralisation and thus promote occurrence of caries activity.⁽¹²⁾ In this regard, indicated that increased resistance to tooth-resin interface to acid efficaciously retard the development of secondary caries. SEM observation at dentin-adhesive interface mentioned the presence of acid-base resistant zone (ABRZ) beneath the hybrid layer in self-etch adhesive systems after acid-base challenges, play an essential role in prevention of secondary caries.⁽¹³⁾ Penetration of monomers into the tooth tissue below the hybrid layer and the chemical interaction between the functional monomer and hydroxyapatite leads to formation of ABRZ. Acid-base resistant zone (ABRZ) is formed only in self-etch adhesive technique but not in etch and rinse adhesive systems.

ADVANTAGES:

- Reduces postoperative sensitivity due to the fact they etch and prime simultaneously⁽¹⁴⁾.
- Since they do not remove the smear layer, the tubules continue to be sealed, ensuing in much less sensitivity.
- They etch the dentin much less aggressively than total etch products.
- Self-etch adhesives are less technique than are etch-and-rinse adhesives.
- The removal of rinsing and drying steps reduces the opportunity of over-wetting or over-drying, either of which can affect adhesion adversely.
- The shallow etch guarantees good resin infiltration.

DISADVANTAGES:

- Bonding of enamel is less effective.
- Bonding to sclerotic and caries affected dentin is probably problematic.
- Might prevent the set of self cure or dual cure resin materials.
- Long term bond to dentin may be prone to hydrolysis.

ROLE IN ESTHETIC DENTISTRY:

- ✚ Self etching adhesive systems used for the restoration of classes 1, 2, 3 and 5 preparations and it provide sufficient enamel etching on the tooth substrate to resist micro-leakage, marginal staining and provide adequate retention of both prepared teeth and non-caries cervical lesions of class 5 restorations.
- ✚ Change in form and the colour of anterior teeth.
- ✚ Increase retention for metallic crowns or for porcelain – fused to metal crowns.
- ✚ Bond all ceramic restorations.
- ✚ Seal pits and fissures.
- ✚ Bond orthodontic brackets.
- ✚ Bond periodontal splints and conservative tooth alternative prosthesis.
- ✚ Repair current restorations (Amalgam, composite or ceramic).
- ✚ Desensitize uncovered root surface.
- ✚ Seal apical restorations placed during endodontic surgery.
- ✚ Penetrate dentin that has been exposed to the oral fluids, making it less liable to caries.
- ✚ Bond fractured fragments of anterior teeth.

CONCLUSION:

Clinicians have seen multiple generations of adhesive systems within the last 20 years. Many of those bonding systems have required multiple steps include etching with orthophosphoric acid, rinsing with an air-water spray, drying, rewetting the preparation, applying the primer, drying, applying the adhesive resin and light-curing⁽¹⁵⁾. With the introduction of clinically reliable self-etching bonding systems to be used

within the restoration of routine tooth preparations, the practitioner can place restoration in an exceedingly more simplified manner.

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ETHICAL CLEARANCE: Not required for a review manuscript

CONFLICT OF INTEREST: Nil

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