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Review Article

An Update Review of Self Etching Primers in Orthodontics

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ABSTRACT:
Over the past decade, adhesive dentistry has been transformed by foremost advances in bonding technology. In the early stage of development, the smear layer was well thought-out as obstruction to efficient dentin bonding. In 1990s, this obstacle was defeat by introduction of self-etching primers. It contains acidic adhesion-promoting monomers for direct bonding to smear layer-covered dentin. The self-etching primer system consists of an etchant and primer available in a single compartment. In order to reduce chair side time for clinician, etching and primer are combined as a one step. The purpose of this article is to explore current knowledge of various dentin bonding agents and development of self etching primer and explained about role of self etching primers in orthodontics.

Keywords: orthodontic bonding, bond strength, self etching primer

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INTRODUCTION

Research on dentin bonding agents has been carried out for over past few decades. The bonding agent should be tough enough to oppose the forces of polymerization shrinkage, finishing procedures, thermal expansion and contraction, and additional thermal and/or mechanical intra-oral environments in order to achieve bonding forces .In Buonocore MG (1955), acid etching technique have been used to remove smear layer for victorious bonding. The extended standing bonding strength is due to the micromechanical bond formation[1]. In 1965, Newman GV reported epoxy resin can be used for attaching brackets[2,3]. At the present time, chemical and light-cured adhesive resins are used generally for routine bonding of fixed appliances.[4] Optimal wettability of solid surfaces is the first requirement in adhesion. To attain optimal wettability, surface free energy must be exploit, that is, the adhesive must exhibit a low contact angle on dentin. At the end of 1960s, Buonocore suggested that micromechanical bonding was due to the formation of resin tags and that principal adhesion of the resins occurred between acid-etched enamel and adhesive resin. Recently, they were tested with various acid-etching procedure with concentration of the phosphoric acid and other alternative.[5-8] Direct bonding of orthodontic brackets to the etched enamel surface has many pros and cons. One of the major disadvantage is loss of surface enamel and demineralization occurs near the bracket and conventional acid etching requires multiple steps of enamel conditioning (acid etching, rinsing, drying, and application of bonding agent).Many studies result show that phosphoric acid etching has been found out the reason for decalcification and the development of white spot lesions around bonded orthodontic appliances.[9,10] .The concept of self etching primer was introduced and self-etching primer system consists of etchant and primer distributed in a single unit. The etching and primer are combined as a single step in bonding procedure where it cause reduction in the number of

steps and also reduces error, resulting in saving time for the clinician. It also results in smaller possibility of enamel decalcification.[11]Self etching primers function both as an etching agent and a primer. Rinsing of enamel is not required after application of the self-etching primer.[12]This current review article explains about the role of self etching primers in the field of orthodontics.

CHARACTERISTICS

Dental adhesive technology has evolved in the past decades with simple clinical procedures. The reduced technique sensitivity, shorter clinical application time and less incidence of post-operative sensitivity have made self-etch adhesive systems a authentic approach when match up to the etch-and-rinse systems.[13,14] The current self-etch adhesive systems are classified based on the number of clinical application steps: one step or two-step adhesives.[15]Two-step self-etch adhesive systems include the use of a hydrophilic etching primer, which combines acidic monomers that simultaneously etch and prime tooth substrate [16,17]and after solvent evaporation, a layer of hydrophobic and bonding agent seal the dentin. One-step self-etch adhesive systems are all-in-one adhesives, which combine the primer and bonding agents, thus containing acidic functional monomers, hydrophilic and hydrophobic monomers, water and organic solvents into a single solution[18,19]. Based on the acid dissociation constants that is the pKa values, the etching strength 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)[20]. The "strong" self-etching shows good bonding performance [21,22] while the bonding effectiveness of "mild" self-etching on enamel is not efficient and can be improved by prior phosphoric acid etching [23,24].

COMPOSITION OF SELF ETCHING PRIMERS

The main constituent of self-etching primers is methacrylate phosphoric acid ester that dissolves calcium from hydroxyapatite. It helps to etch and prime the enamel surface prior to bonding[10].The phosphate group of the methacrylated phosphoric acid ester dissolves calcium and removes it from hydroxyapatite[25]. Hereby calcium forms a complex with the phosphate group to a certain extent than being washed away and becomes assimilated into the network when the primer polymerizes.[26]

MECHANISM OF ACTION

1) Acid groups attached to the monomer are neutralized by forming a complex with calcium from hydroxyapatite.

2) As the solvent is driven from primer during the airburst step, the viscosity increases, slowing the transport of acid groups to the enamel interface.

3) As the primer is light cured and the primer monomers are polymerized, movement of acid groups to the interface is delayed.

GENERATIONS OF DENTIN BONDING AGENTS[4]

First Generation

In 1956, Dentin bonding agents first generation were developed by Buonocore. He found out that use of glycerophosphoric acid dimethacrylate (NPG-GMA) containing resin will bond to acid etched dentin[27].These bonding agents were formulated by ionic bonding to hydroxyapatite or covalent bonding or hydrogen bonding to collagen. The water content in this resin weaken this bond. After active research, Bowen used coupling agent to get the better of the weak bond in the presence of water[28]. He used NPG-GMA which a primer or something which improves the adhesion between enamel/dentin and resin materials by chelating with surface calcium, where one end would bond to dentin and other would polymerize with the resin. One of the major disadvantage is bond strength was very less and was in the range of 1-3 Mpa .

Second Generation

At the end of 1970's, second generation bonding agent was introduced. This generation was refined coupling agents used in the first generation. In this, polymerizable phosphates were added to bis-GMA resins to enhance bonding to the calcium in tooth structure and it is mineralized. A greater part of these integrated halophosphorous esters of unfilled resins such as bisphenol-A glycidyl methacrylate, or bis-GMA, or hydroxyethyl methacrylate, or HEMA[29]. The generation is the formation of ionic bond between chlorophosphate groups and calcium. The major disadvantage is the phosphate bond to calcium in the dentin and it was not influential enough to resist the hydrolysis resulting from water immersion. The bond strength was reduced and it is 4-6 Mpa.

Third Generation

In the late seventies and early 80's, third Generation dentin bonding agents were presented. An acid etching technique was introduced. This was intended to modify or partially remove the smear layer [30]. This opened the dentinal tubules and allowed a primer to be placed after the acid was completely rinsed away.The acid must be rinsed completely before the primer is applied. The primer contains hydrophilic resin monomers which include hydroxyethyltrimellitate anhydride, or 4-META, and biphenyl dimethacrylate. The primers contain a hydrophilic group that penetrate the smear layer, modifying it and promoting adhesion to dentin, and the hydrophilic group of the primer creates

adhesion to the resin. This generation showed a considerable increase in the bond strength[31].

Fourth Generation

The fourth generation dentin bonding agents were introduced in 1980 and 1990. The fourth generation materials was intended to achieve complete removal of smear layer and still is considered as the gold standard among dentin bonding agent. Fusayama and colleagues simplified bonding to enamel and dentin by etching the preparation with 40 percent phosphoric acid[32]. In this generation, three principal components are etchant, primer and bonding agent which are packaged in separate bottles and applied one after the other. Nakabayashi and colleagues reported the formation of a hybrid layer resulting from the polymerized methacrylate and dentin in 1982 [33]. The total-etch technique is one of the main highlight of fourth-generation bonding systems[34,35]. The total-etch technique permits the etching of enamel and dentin at the same time using phosphoric acid for 15 to 20 seconds. The surface must be left moist ("wet bonding"), however, in order to avoid collapse of collagen, the application of a hydrophilic primer solution can percolate the exposed collagen network forming the hybrid layer. [36,37]Bond strengths for these adhesives were 20 Mpa.

Fifth Generation

The fifth generation bonding system was modified by decreasing the clinical steps which amounted to reduced working time. The fifth generation consists of two variety of adhesive materials: the so-called "one-bottle systems" and the self-etching primer bonding systems.

One-bottle systems: To ease the clinical use, "one-bottle" systems made together the primer and adhesives into one solution which is to be applied after etching enamel and dentin simultaneously (the total-etch wet-bonding technique) with 35 to 37 percentage phosphoric acid for 15 to 20 seconds.[36] This bonding mechanism create a mechanical interlocking with etched dentin by means of resin tags, adhesive lateral branches and hybrid layer formation and show high bond-strength values both to the etched enamel and dentin[37,38].

Self-etching primer: Watanabe and Nakabayashi brought out a self-etching primer that was an aqueous solution of 20 percent phenyl-P in 30 percent HEMA for bonding to enamel and dentin simultaneously[39].

The combination of etching and priming steps decrease the working time, eliminate the washing out of the acidic gel and also avoid the risk of collagen getting collapsed. However, the self-etching primer solution also has some drawbacks. The solution must be refreshed continuously because its liquid formulation cannot be controlled where it is placed[40] and often a residual smear layer remained in between adhesive material and dentin[41].The bond strength is 3 to 25 Mpa.

Sixth Generation

The sixth generation bonding system is self etching primer and it was introduced in late 2000s,where it eliminate the etching step, or included it chemically in one of the other steps: (self-etching primer + adhesive) acidic primer applied to tooth first, followed by adhesive or (self-etching adhesive) two bottles or unit dose containing acidic primer and adhesive; a drop of each liquid is mixed and applied to the tooth. The evaluations of these current systems showed a sufficient bond to conditioned dentin while the bond with enamel was less effective. It may be due to sixth-generation systems was composed of an acidic solution that cannot be kept in place, must be refreshed continuously and have a ph that is not enough to properly etch the enamel surface[42].

Seventh Generation

The most recent of adhesive system is one-bottle self-etching system which is not much complicated. This generation is all ingredients required for bonding are placed and delivered from a single bottle[43].This makes things easier the bonding protocol as the claim was that could be achieved consistent bond strengths while completely eliminating the error. On the other hand, incorporating and placing all of the chemistry required for a viable adhesive system into a single bottle remain stable over a period of time[43].

Eighth Generation

In 2010, voco America launched voco future bond DC as 8th generation bonding agent, which contains nanosized fillers[44]. The addition of nano-fillers with an average particle size of 12 nm raise the percolation of resin monomers and the hybrid layer thickness .So ,result in the improvement of the mechanical properties of the bonding systems.[45,46]

ADVANTAGES

Enamel preparation would be less technique sensitive and less time consuming

- Clinicians can save time and reduce the potential for error and contamination during the bonding procedure.[47]
- Isolation should be less of a problem compared to acid etching

DISADVANTAGES

1) Self etching primers Shear bond strength value is lower when compared to conventional acid etching.

2) When assessing the site of bond failure, the percentage of brackets failing at the enamel/resin interface was increased with the new self-etch primer (72 and 63 %) compared with the conventionally bonded control.[48]

ROLE IN ORTHODONTICS

- Self etching primers have less extent of enamel dissolution by treatment when compared to acid etching.
- It has the advantage of minimizing the amount of enamel loss. They do not cause any serious problems at debonding of the orthodontic brackets. Studies showed that self-etching primer resulted in significantly lower bond strength than when using phosphoric acid etching. It was shown that shear bond strengths of about 8–9Mpa were obtained for self-etching primer used with composite resin.

CONCLUSION

From many studies, it can be observed that the shear bond strength while bonding with self etching primer is less when compared to the conventional technique. Application of self-etching primers and phosphoric acid reduced the water contact angle on dentin to a similar degree. Self-etching primers are effective, but only future long term clinical studies will prove their clinical reliability. Dentin wettability was affected by the pH of the used self-etching primers or phosphoric acid. The future research are needed on biocompatibility, bond strength, and viscosity for self adhesive.

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