

# Hybrid layer of etch and rinse versus self-etching adhesive systems: A comparative study

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## ABSTRACT

**Aim:** This study is to evaluate the effectiveness in the formation of resin tags, and hybrid layers of self-etching adhesives and total etch adhesives of total etch and two self-etching bonding systems to dentine surface by scanning electron microscopic study. The etch and rinse system shows thick hybrid layer than self-etching systems.

**Result:** The resin tags formation in etch and rinse system is much longer than self-etch sixth and seventh generation bonding systems and bonding interface is more uniform in two self-etching bonding systems than total etch bonding resin supporting null hypotheses. **Conclusion:** Self-etching bonding agents containing acidic monomer is able to penetrate dissolve the smear layer to form a more uniform hybrid layer. However, the long-term durability of self-etching bonding system should be evaluated.

**Key words:** Bonding, dentin, hybrid layer, total etch and self-etch

## INTRODUCTION

Resin dentin inter diffusion zone and formation of resin tag are determined by penetration of resin into demineralized collagen fibers. The success of composite restoration depends on micromechanical retention created in dentin. The hybrid layer which is formed in inter tubular dentin plays a major role in micro mechanical retention. The ability to preserve the tooth structures depends on the micromechanical retention achieved by means of resin infiltration into demineralized tooth structure by acid etching introduced by Buonocore. Dentin adhesives currently available are three steps, two steps, and single step systems depends on how

the cardinal steps of etching, priming, and bonding tooth substrate is accomplished or simplified. Etch and rinse has been consolidated into two steps of etching and priming along with adhesives. Single bottle system manufacturer add more concentration of acidic monomer in the primer formulations creating self-etching adhesives. Water is integral part of these self-etching systems that allows the acidic monomers to be so effectively ionized in order to demineralize the tooth substrate. These primers reduces etching and rinsing step present in total etch technique, examples of two step self-etch technique. Self-etching primer eliminate the problem of incomplete resin infiltration that is present in total etch technique as etching and priming is done simultaneously. Bonding mechanism of dentin bonding agents is based on penetration of ambiphilic molecules into

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acid etched dentin resulting in hybrid layer. Null hypotheses are, use of self-etch adhesives in which infiltration of the resin occurs simultaneously with the self-etching process, the risk of discrepancy between both collagen and resin infiltration will be nonexistent. However, morphological evidence were already provided showing discrepancies between the depth of demineralization and depth of resin infiltration.<sup>[1,2]</sup> Scanning electron microscopic (SEM) study was done to compare thickness of hybrid layer and resin tag formations in total etch and two self-etching bonding agents. Study was done to compare thickness of hybrid layer and resin tag formation of total etch and two self-etching bonding agents.

### Specimen preparation for scanning electron microscopic study

Eighteen freshly extracted noncarious mandibular teeth were selected and stored in distilled water with 0.2% thymol until the start of the procedure. All teeth were grounded to get flat mid coronal dentinal surface using diamond bur under water irrigation. Then the surface was polished with 220, 300, and 600 grit silicon polishing disc. Etch and rinse bonding agent TE — Ecnom Ivoclar Vivadent Batch No 20512. Sixth generation, two step bonding agent Adper Prompt 3M ESPE Germany Batch No 286523, and seventh generation, one step bonding agent G-Bond GC Corporation Japan 0703081 were used and they were bonded according to manufacturer instruction.

For etch and rinse dentinal surface was etched with 37 % phosphoric acid gel for 15 s, washed with water and gently dried with oil free air and total etch fifth generation bonding agent (TE Ecnom Ivoclar Vivadent) was applied on dentin and light cured for 20 s. Self-etching two bottles sixth generation one drop of liquid A and one drop of liquid B (Adper Prompt 3M ESPE) were dispensed into mixing well. Both the components were mixed with disposable applicator until clear yellowish solution obtained then adhesive resin was applied on dentinal surface and massaged it over the entire surface for 15 s by applying pressure, and the adhesive was thoroughly dried to a thin film by stream of oil free air and second coat was applied again and dried to thin film by a stream of air and light cured for 15 s. Self-etching single bottle Bonding agent (GC-Bond — GC Corporation) was dispensed into the dish after shaking the bottle well. With disposable applicator adhesive applied on the dentinal surface and left undisturbed for 5-10 s and dried with oil free air under maximum air pressure and light cured for 10 s. All the specimens were stored in water for 24 h. After thermocycling procedure all the specimens were sectioned parallel to long axis using a diamond IsoMet saw (Buehler, Lake Bluff, NY, USA) at slow speed under water coolant to expose resin dentin interface and subjected to microscopic study. Specimen was mounted on metal stubs and sputtered with 15 nm platinum in sputtering machine (JEOL JFC 1600, Japan electronics limited). Specimen was attached with a metal bolt with a double sticker and examined with

scanning electron microscope (JEOL JSM 6360 Japan Electronics Limited) using acceleration voltage of 15 Kv. Dentin resin interface was viewed at  $\times 1000$  magnification.

### RESULTS

SEM analysis shows that the bonding agent was well adapted to the dentin in all specimens. In some cases, voids were present in the adhesive layers of self-etching bonding agents. This may be due to dehydration or desiccation in the high vacuum chamber during specimen processing for scanning microscopic study. Large defects were seen below the resin surface.

In SEM study, total etch bonding agent showed up to 8  $\mu\text{m}$  hybrid layer formation and resin tags measuring 5  $\mu\text{m}$  to 10  $\mu\text{m}$  in self-etch two bottle bonding agent hybrid layer measures about 2  $\mu\text{m}$  to 3  $\mu\text{m}$  and resin tags measuring about 5  $\mu\text{m}$  to 7  $\mu\text{m}$  was present. Self-etching one bottle system hybrid layer self-etching sixth and seventh generation bonding measures about 3  $\mu\text{m}$  to 5  $\mu\text{m}$  hybrid layer and resin tag measuring about 2  $\mu\text{m}$  to 3  $\mu\text{m}$  were present. Resin tag length and hybrid layer thickness of sixth and seventh generation bonding agent are less when compared with fifth generation total etch bonding agent. The apex of resin tags was observed in all the specimens.

### DISCUSSION

Micromechanical retention of composite restoration is based on an exchange process by which the inorganic tooth substrate is exchanged for bonding resin in acid etching. The hydrophilic adhesive resin penetrates and adapts to the demineralized inter tubular dentin and exposed collagen fibrils resulting inter-diffusion zone is termed as a hybrid layer.<sup>[3]</sup> The formation of hybridized dentin greatly depends upon the permeability of the dentin substrate to which the dentin bonding agent is applied, as well as diffusion potential of the applied adhesive monomer.<sup>[4]</sup> Total-etch adhesive systems self-etching adhesives<sup>[5]</sup> are more likely to have discrepancies between the extent of demineralization and the depth of infiltration of the adhesive resin. Such mismatch between demineralization and resin infiltration has been claimed to affect the micromechanical retention and durability of resin-dentin bonds. Null hypotheses are, use of self-etch adhesives in which infiltration of the resin occurs simultaneously with the self-etching process, the risk of a discrepancy between both collagen and resin infiltration will be nonexistent. However, morphological evidence were already provided showing discrepancies between the depth of demineralization and depth of resin infiltration.<sup>[6]</sup> SEM study was done to compare the thickness of the hybrid layer and resin tags of total etch and two self-etching bonding agents. Mandibular first molars were selected in this study to obtain flat 2 mm mid coronal dentinal surface using slow rotating diamond disc under water irrigation. Smear layer

was standardized with 220, 300, 600 grit silicon carbide disc. In SEM study total etch bonding agent showed up to 8  $\mu\text{m}$  hybrid layer formation and resin tags measuring 5  $\mu\text{m}$  to 10  $\mu\text{m}$ . An aqueous hydroxy-methyl methacrylate in total etch and rinse bonding agent promotes impregnation of resin into the exposed collagen<sup>[7]</sup> and removal of smear layer aids in developing long resin tags by completely opening dentinal tubules. In self-etching sixth generation bonding agent hybrid layer measures about 2  $\mu\text{m}$  to 3  $\mu\text{m}$  and resin tags measuring about 5  $\mu\text{m}$  to 7  $\mu\text{m}$  and in self-etching seventh generation system hybrid layer measuring about 3  $\mu\text{m}$  to 5  $\mu\text{m}$  and resin tag measuring about 2  $\mu\text{m}$  to 3  $\mu\text{m}$  were seen. In self-etch systems smear layer occluded dentinal tubules without resin infiltration were seen in all the specimens of sixth and seventh generation. Adhesive mechanism of fifth generation bonding agent shows nonuniform in the infiltration of resin in etched dentin when compared with uniform hybrid layer formation in both self-etching bonding agents.<sup>[8]</sup> This uniformity is due to simultaneously etching and priming followed by adhesive present in self-etching bonding agents. This study states that deeper etching done as separate etching technique while using total etch bonding agent results in poor penetration of adhesives. This may be due to the collapse of collagen fibrils due to desiccation of fibrils. Mechanism of adhesion in self-etching adhesives was to maintain the smear layer and incorporated in the hybrid layer. Two bottle packing of the sixth generation and single bottle all in one system does not show any difference in resin penetration and hybrid layer formation.

## CONCLUSION

Self-etching bonding agents containing acidic monomer is able to penetrate dissolve the smear layer to form a more

uniform hybrid layer. 10-methacryloxydecyl di-hydrogen phosphate monomer partially dissolves smear plug resulting in partial opening of dentinal tubule resulting in less resin tag formation. Displacement of water into the resin dentin interface will result in hydrolysis of resin in the hybrid layer. Long-term durability of self-etching bonding system should be evaluated.

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## Conflicts of interest

There are no conflicts of interest.

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