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ORIGINAL RESEARCH

SEM Analysis of Various Pre Treatment Methods on the Quality of Acid Etched Enamel

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ABSTRACT:
Introduction: Acid etching causes a selective demineralization that increases the free surface energy, enamel porosity, and increase in surface area. In order to decrease marginal microleakage, alternative enamel pre treatment methods have been proposed: air abrasion, high output lasers or combined techniques. **Objective:** The objective of this study is to compare the etching patterns of various pre treatment techniques of enamel with conventional 37% phosphoric acid etchant, laser, air abrasion with and without activation under scanning electron microscope. **Materials and Method:** Forty extracted anteriors and premolars were allocated into 8 groups (5 each): (1) 37% phosphoric acid etching (2) phosphoric acid etching with activation (3) Laser etching (4) Laser etching with phosphoric acid etching (5) Laser etching with phosphoric acid etching with activation (6) Etching with air abrasion (7) Etching with air abrasion with phosphoric acid etching (8) Etching with air abrasion with phosphoric acid etching with activation. **Results:** In the laser-etched enamel preparations, surface layer was severely fissured and probably denatured, which gave rise to a more heterogeneous surface than that obtained by acid etching. The specimens conditioned with Er : YAG laser followed by phosphoric acid etching with activation resulted in a more homogenous surface pattern than others in the same group. **Conclusion**: Based on **e**tching patterns observed on buccal surface of teeth , 37% phosphoric acid etching with activation gave better etching pattern (type 2) followed by laser etching with activation of etchant (type 1), air abrasion with etchant , air abrasion only, laser only.
Keyword: Etching patterns, Air abrasion, Laser, Scanning electron microscopy.

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INTRODUCTION

Retension of dental resin material is enhanced greatly by pre treatment of enamel surfaces with certain inorganic acids or chelators.[1] The acid solutions acts by partially decalcifying the enamel, creating microiregularities on the surface of teeth. The procedure known as acid etching, has received much attention from investigators, since the quality of acid etch is a crucial factor in the retension of materials. It is commonly assumed that to obtain good bond strength and minimal enamel loss, the enamel must be etched for 15 to 60 seconds with 35% to 40% phosphoric acid.[2] In order to control the enamel loss, various pre treatment methods have been investigated with the intent to enhance the effectiveness of etching the enamel surface. A significant advantage has been demonstrated in having a clean, debris free surface prior to etching. It has been recommended that an increase in the amount of etchant exposure time would provide a cleaner surface.[3] Among the various techniques currently in use to promote dental surface conditioning, high-output lasers, such as Er:YAG laser, have been studied as an alternative method to selectively remove oral mineralized tissues for restorative purposes. Hard dental tissue ablation by Er:YAG laser is based on the absorption of light energy by the water and hydroxyapatite present in the enamel, which have high absorption coefficient close to 2.94 µm. This laser has been used for removal of enamel and dentin caries with no evidence of thermally induced damage to the surrounding tissues and/or to the pulp. Another method of enamel pretreatment, the air abrasion technique (sandblasting) has been described in the literature.[2] Air-abrasion technology makes use of a high-speed stream of aluminum oxide particles (50/90 µm), propelled by air pressure. Previous research has shown that the air-abrasive technique results in surface changes in the enamel. The air-abrasive technology has been advocated not only for cavity preparation, but also for the preparation of dentin and enamel, with a view to obtain micromechanical bonding. It has been suggested that the air-abrasive technique could contribute to a better bond system with less enamel loss. It has been suggested that this method may serve as an alternative to acid etching of enamel and may reduce patient's discomfort by eliminating the vibration, pressure and noise associated with rotational burs mounted on handpieces (Wright et al 1999).[4]Since surface cleaning and an etching effect do occur simultaneously with this treatment, it has been suggested that this method could represent a significant time saving for practitioners. This study aims at comparing the etching pattern of phosphoric acid with and without activation, laser etching with and without activation, air abrasion etching with and without activation.

METHODS AND MATERIAL

To investigate buccal surface etching patterns, 100 human anterior and human premolar were collected and stored in formalin. Specimens were prepared by lightly polishing the crowns of the teeth with pumice and a soft bristle brush. Teeth were sectioned at the cement enamel junction using a sectioning machine, and the roots were discarded. The buccal surfaces were washed thoroughly in water and dried. Specimens were randomly divided into 8 groups (n=12) and in each specimen, a 4×4 mm area was treated. Eight experimental groups each consisting of 12 samples were prepared as follows:

Group 1- The samples were etched with 37% phosphoric acid for 15 seconds and thoroughly rinsed with distilled water and gently air dried.

Group 2- All samples were acid etched with 37% phosphoric acid with rubbing action

Group 3- The samples were irradiated with Er : YAG laser (Fotona) using total energy of (560 W). During laser treatment, the pre determined area was irradiated using a handpiece supplied with the laser system.

Group 4- The samples were treated with laser followed by acid etching for 15 seconds using the parameters described above.

Group 5-The samples were treated with laser followed by acid etching with rubbing action for 10 seconds.

Group 6- The samples were air abraded using 50µm alpha alumina particles from a distance of three millimetre using the unit(name)

Group 7- The samples were air abraded followed by phosphoric acid etching for 15 seconds.

Group 8- The samples were air abraded followed by acid etching in rubbing action for 10 seconds.

These samples were dehydrated with ethanol , dried in vacccum and coated with gold palladium layer. The SEM images were observed under a Htachi Scanning electron microscope operated at 20 Kv accelerating voltage. Photographs of different treatment groups were then qualitively compared by three investigators.

RESULTS

When tangential ground surface of teeth were etched with 35% phosphoric acid for 15 seconds type 1 etching pattern was observed. Dissolution of prism cores and boundary region were observed, however conditioning was not uniform along the surface. When acid was applied with rubbing action, the prism peripheries were obscured resulting in more uniform etching. Based on conventional SEM, the natural enamel surface etched for 15 seconds were classified into 5 shapes: prismless enamel, a cone shaped prism structures with indistinct circular prism peripheries, type 1 and type 2 etching patterns and a complex of type 1 and type 2 etching patterns. The last type showed relatively intact prism peripheries and bodies, but there were deeper slits between them. This was named type 1-2.

Laser etched groups produced a Type III acid-etching pattern with more micro cracks, and the surface destruction was more prominent. Specimens conditioned with Er:YAG laser alone showed areas of ablated tissue with non-lased enamel within the irradiated area shows that technique using Er:YAG laser irradiation followed by phosphoric acid etching resulted in a more homogeneous surface pattern than that exhibited by the specimens treated with laser alone.

The air abraded surface reveals an irregular surface clearly degraded by the air abrasion process but without microscopic topographical features. The group – with combination preparation with air abrasion in conjunction with acid etching with 35% phosphoric acid for 15 seconds demonstrates the macroscopic surface irregularities and topography created by air abrasion, as well as microscopic irregularities generated from the demineralised ends of enamel rods created by the etching process.

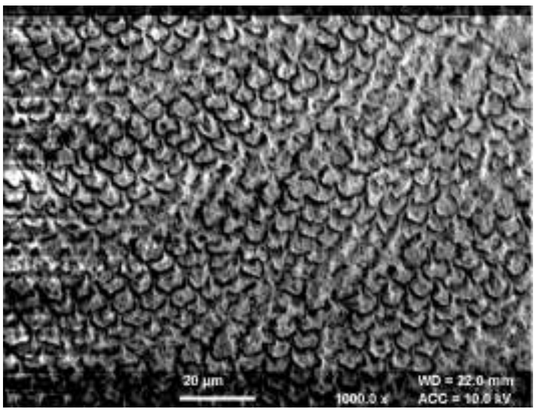

Figure 1: SEM image of etching with activation

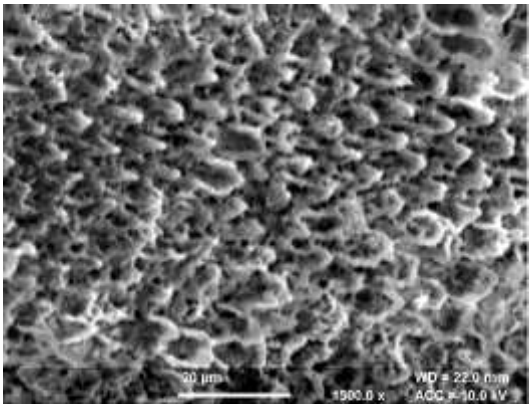

Figure 2: SEM image of etching with phosphoric acid without activation

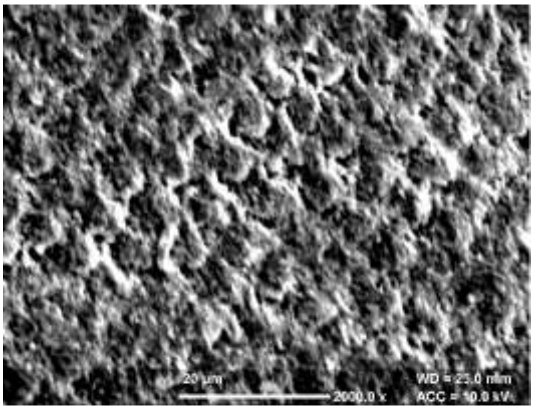

Figure 5: SEM image of etching of Laser with phosphoric acid with activation

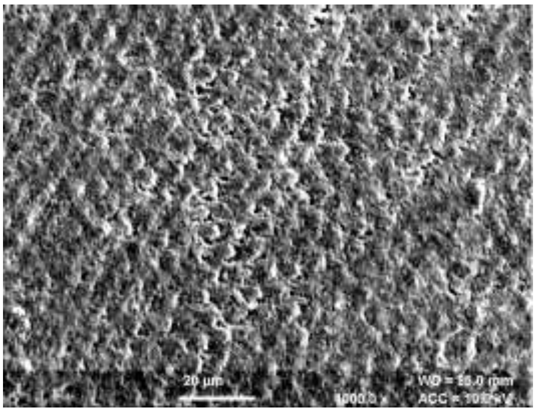

Figure 3: SEM image of etching with laser

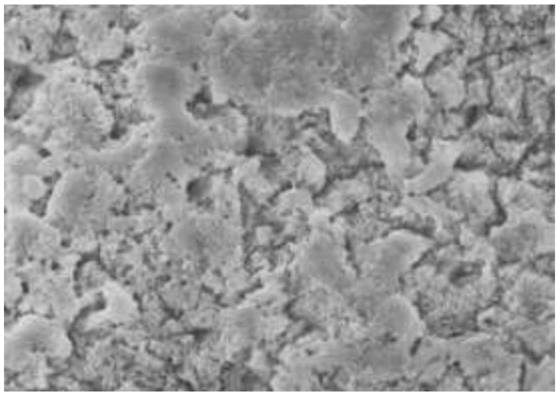

Figure 6: SEM image of etching of air abrasion

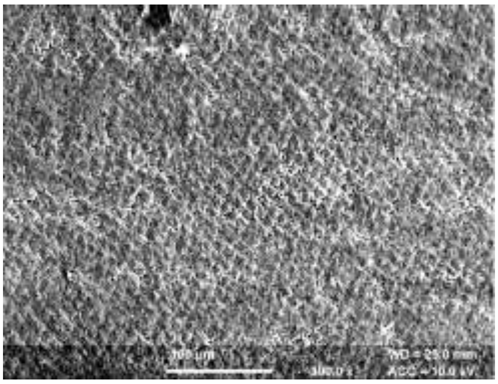

Figure 4: SEM image of laser etching with phosphoric acid

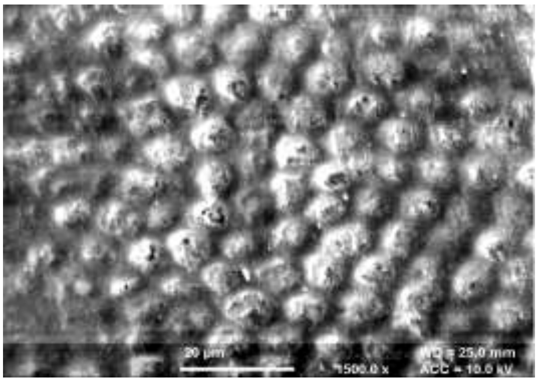

Figure 7: SEM image of etching with air abrasion and phosphoric acid

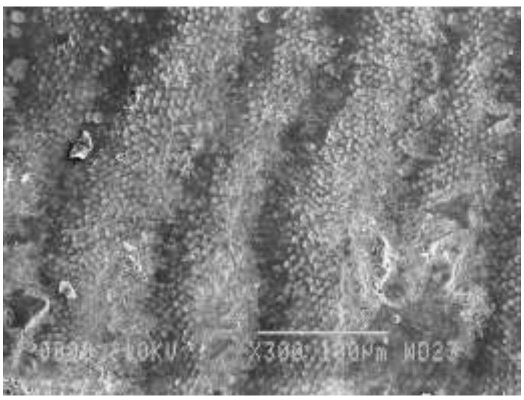

Fig 8: SEM image of air abrasion with phosphoric acid with activation

DISCUSSION

Conditioning surface enamel with phosphoric acid is the standard method for preparing the enamel surface prior to bonding sealant materials. The etchant creates an increased surface area of irregular enamel and allows the formation of resin tags, which provides a micro-mechanical interlocking of the enamel-sealant interface.[3] The development of new techniques to increase the bond strength between the dental surface and the adhesive/composite resin systems (e.g. mechanical adhesion) may have profound therapeutic implications in dentistry. Among the various techniques currently in use to promote dental surface conditioning, high-output lasers, such as Er:YAG laser, have been studied as an alternative method to selectively remove oral mineralized tissues for restorative purposes. Hard dental tissue ablation by Er:YAG laser is based on the absorption of light energy by the water and hydroxyapatite.

Er:YAG laser conditioning is proved to be effective for hard tissue ablation without any thermal side effects. Laser irradiation produces an amount of surface roughness comparable to acid etching. Er :YAG laser treated enamel is resistant to acid attack when compared with phosphoric acid etched enamel. The Er:YAG laser ablation is the result of an explosive vapourization of water within the tooth.

Moreover, when used at appropriate doses, Er:YAG laser can selectively remove hydroxyapatite crystals present on enamel surface resulting in an irregular surface pattern that could potentially improve the micromechanical retention of adhesive systems to the enamel.

A combination of air abrasion and phosphoric acid etch pretreatment has been reported to create an enamel surface, whereby the bonded sealant material has demonstrated the highest shear bond strengths to intact enamel. Our study alike L. Bevilacqua et al 2007 showed air abrasion inadequate, due to the observation that poor surface roughness and more microleakage occur with air abrasion alone if compared with acid etching alone [Olsen et al., 1997; Hatibovich-Kofman et al., 1998; Ellis et al., 1999; Waveren Hogervorst et al., 2000]. The results showed that the bond strength of the sandblasted groups was significantly lower than that of the etching groups. This indicates that sandblasting is not an alternative for the acid-etching technique currently used in orthodontic practice.

CONCLUSION:

This study examined the various enamel etching with activation and without activation effects on the buccal surface of human extracted teeth with scanning electron microscopy. The results showed that the etching pattern of air abraded groups was significantly lower than that of the etching groups. This indicates that sandblasting/air abrasion is not an alternative for the acid-etching technique currently used in orthodontic practice. Er:YAG laser etching was inferior to that obtained after conventional acid etching. Based on findings of this investigation etching patterns are observed on buccal surface of teeth , 37% phosphoric acid etching with activation gave better etching pattern (type 2) followed by laser etching with activation of etchant (type 1), air abrasion with etchant , air abrasion only, laser only.

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