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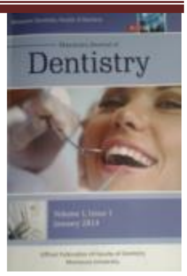


# *Ceramic surface treatment methods prior to orthodontic bonding*

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***Abstract:***

**Aim:** To present a current review on the possible methods of surface treatment of porcelain prior to orthodontic bonding.

**Methods:**Since the ceramic structure is inert, numerous methods of surface treatment have been attempted to improve the bond strength of orthodontic attachments to ceramic surface. These methods could be mechanical or chemical or combination. This review discusses these different methods to help guide the orthodontist which method is suitable and provide the clinically adequate bond strength.

**Results:** Mechanical preparation of the porcelain surface results in permanent destruction to the porcelain glaze and compromise the original luster and integrity of the ceramic surface. Laser application to the ceramic surface has also been studied as a possible surface treatment procedure. However, it is a highly costly technique. Conditioning the porcelain surfaces with 37% phosphoric acid (PA) followed by a silane coupling agent produced clinically acceptable bond strength. It has been suggested to use PA as a substitute to hydrofluoric acid (HFA) etching in a trial to promote adhesive failure due to the expected lower bond strengths and thus decrease the risks to the ceramic surface. Silane coupling agents have been documented to improve bond strength to porcelain substrates.

**Conclusion:** There are different methods for surface treatment of porcelain prior to orthodontic bonding. According to this review the most suitable less destructive method to the porcelain following debonding is using 37% PA followed by silane application as it can produce clinically accepted bond strength as proved in the literature. Yet, continuous development of new surface treatment methods and materials is highly important.

**Keywords:** Surface treatment, Ceramic, Orthodontic bracket, Bonding

## *Introduction*

The use of all-ceramic crowns has increased dramatically due to the increased demand for esthetic restorations. With the increased number of adults who seeks orthodontic treatment, orthodontists face the challenge of bonding to different types of all-ceramic materials as bonding of orthodontic brackets to these materials differs from bonding to enamel surface.[1]

Since the ceramic structure is inert, numerous methods of surface treatment have been attempted to improve the bond strength of orthodontic attachments to ceramic surface. These methods could be mechanical or chemical or combination.[2]

The surface treatment method is one of many factors affecting the bond strength to porcelain such as ; the type of porcelain , surface conditioning , the bracket material and retention mode , the bonding adhesive properties , the light curing source and the skill of the clinician.[3, 4]

The orthodontic appliance must have adequate retention to resist the heavy occlusal and masticatory forces immediately, upon bonding, and during the whole course of the orthodontic therapy.[5-7]The ability of a bracket to resist these forces without being debonded from the tooth surface can be defined as bond strength. The most common measuring methods of bracket bond strength are shear and tension tests. They provide similar and clinically comparable values.[8-10] It has been documented that the clinically accepted shear bond strength lies between 6 and 8 MPa with 2.89 MPa as a bare minimum.[11]

## Surface Preparation

Since the ceramic structure is inert, numerous methods of surface treatment have been attempted to improve the bond strength of orthodontic attachments to ceramic surface. These methods could be mechanical or chemical or combination.[2]

### 1. Mechanical Preparation

Preparing the ceramic surface mechanically includes the removal of the porcelain's glaze layer and/or making the ceramic surface rough to gain greater surface area for enhanced chemical retention. Multiple choices are obtainable and are passably time saving techniques. Using coarse diamond burs, green stones, and abrasive discs has been well documented in the literature.[12-14]

Zachrisson et al (1996) stated that intra-oral sandblasting performed with the aid of small specks of aluminium oxide can remove the porcelain glaze better than diamond burs or stones. This can be attributed to the very small area of surface that is removed. Accordingly, a more homogenous surface is produced.[15] In spite that this needs minimal chair side time, the aluminium oxide specks are not easy to handle intraorally. In addition, it needs rigorous rinse of the area. It was found that the highest surface roughness was produced by fine diamond roughening and sandblasting when compared acid etching.[13] Also, it was found that mechanical prepration of the porcelain surface results in permanent destruction to the porcelain glaze and compromise the original luster and integrity of the ceramic surface.[13, 16]

Eustaquio et al examined the tensile bond strengths of orthodontic attachments adhered to both glazed and deglazed porcelains using five adhesive systems. It was found that the bond strength of both glazed and deglazed porcelains showed no significant variance. The bonding procedure can lead to unrepairable destruction to the porcelain surface.[17]

Türkkahraman et al compared the influences of different glazed porcelain surface treatment protocols on the SBS of CB bonded to them. The results showed that surface conditioning with HFA and a silane coupling agent resulted in the stongest adhesion. The bond strength did not increase significantly by sandblasting prior to HFA and silanization. It was also found in this study that silanization of sandblasted ceramic produced weak results in vitro.[18]

Nebbe et al found that deglazing may not be mandatory for adhesion of orthodontic brackets to ceramic substrates.[19] Several studies found that acid etching prior to silane application achieved bond strength within the accepted clinical range thus eliminating the need to mechanically roughen the ceramic surface.[13, 20-24]

### 2. Laser

Laser application to the ceramic surface has also been studied as a possible surface treatment procedure. However, it is a highly costly technique.[15]With the introduction of laser systems, great efforts were made to use this novel tool for etching of ceramic surfaces. This can be attributed to the advantages it provides as easy usage, safety, and more efficiency.[25]There are numerous types of lasers used for porcelain etching like CO2, Nd:YAG, Erbium lasers.[25]

Hosseini et al found no significant different effects on SBS of metal brackets bonded to feldspathic porcelain conditioned with HFA and Nd:YAG laser with power of 1.5 or 2 W.[26] However Najafi et al concluded that deglazing prior to HFA conditioning produced the strongest bond, but CO2 laser application resulted in sufficient bonding that the HFA step can be eliminated. It was recommended that deglazing not considered as a primary step before CO2 laser application.[27]

Sabuncuoğlu et al found that laser etching with either an Nd:YAG or Er:YAG laser was stated to be more effecient and consumes less time than both HFA acid and sandblasting for the conditioning of deglazed feldspathic porcelain.[28]

### 3. Chemical Preparation

The acid used in the chemical preparation of a ceramic surface produces a series of micropores due to the selective dissolution of the glassy component within the porcelain matrix.[12] The best protocol described in a recent review is etching with 9.6% HFA for 1 minute, rinsed for 30 seconds, and then air-dried.[3] The etching with HFA should be followed by an application of silane.

However the hazards associated with the use of HFA intraorally have been mentioned in literature.[29] These hazards include soft tissue burns and both soft and hard tissue necrosis. Along with the harmful biological effects, etching with HFA is destructive through its chemical reaction with silica thus will necessitate refinishing.[30] In addition, owing to the high bond strengths obtained by HFA etching,[22] bond failure is often cohesive within the ceramic, which is a greater risk for irreversible damage to the ceramic surface.[31] Several authors have suggested using PA as a substitute to HFA etching in a trial to promote adhesive failure due to the expected lower bond strengths and thus decrease the risks to the ceramic surface.[12, 19, 32, 33] Thus removing the remaining adhesive from the porcelain surface after debonding is much easier.[34]

Bourke and Rock in their investigation figured out that the SBS values were comparable when comparing the groups that were etched with HFA with those that etched with PA.[12] Thus if using HFA provides no additional benefit, one should terminate it.[34]

In a study by Lamour et al, treating porcelain surface with 37% PA was found to produce clinically adequate bond strength when compared with that produced by using HFA.[35] Buyuk et al found that CAD/CAM material types and bonding protocols influenced SBS, but the conditioning protocols using HFA or PA did not.[1] Also Purmal et al in their study found that with both conditioning methods, no significant difference was observed. Thus conditioning with PA considered safer and should make it easier for clinicians to remove the adhesive remnants on the ceramic surface after debonding.[36]Guimarães et al concluded that the best procedures for bonding orthodontic attachments to ceramic substrates is the utilization of PA prior to silane application. This can be attributed to its ability to withstand the occlusal forces applied during orthodontic treatment without causing permenant failures in the ceramic restoration.[37]

Narrative evidence advocates that orthodontic attachments bonded with silane coupling agents and PA or HFA provides clinically adequate bond strength through the course of orthodontic treatment.[13, 16, 19, 35, 38]

### 4. Silane coupling agents

Silanes are hybrid organic-inorganic compounds that can act as intermediate coupling agents to enhance bonding between different, inorganic and organic substrates.[39]Silanes are highly efficient in enhancing bonding for silica-based materials such as porcelain.[40] They have been documented to improve bond strength to porcelain substrates.[24, 41-43] The silane reacts with the silica composing the porcelain and the organic groups of the adhesive resin, thus making a link between the two materials.[2]

Faltermeier et al found that etching with 37% PA for 2 minutes and followed by a silane coupling agent application seems to enhance the bonding of orthodontic attachments to porcelain surface.[44]Guimaraes et al also found that surface conditioning with PA, followed by silane application provides a bond strength that is adequate enough to withstand the orthodontic forces applied during treatment, without resulting in permenant damage in porcelain.[37]Lifshitz et al also concluded that conditioning the porcelain surfaces with 37% PA followed by a silane coupling agent produced clinically acceptable bond strength.[21] Also, PA can counterbalance the alkalinity of the absorbed water layer, which is found on all porcelain surfaces in the oral cavity and thus improve the chemical activity of any silane primer when used afterwards.[45] Therefore, the use of PA prior to silane application is considered an acceptable method for adhesion of orthodontic attachments to ceramic surfaces.[34]

Monobond Plus (IvoclarVivadent, Schaan, Liechtenstein) universal primer is claimed by its manufacturer to be satisfactory with all kinds of restorative dental materials. It is composed of a greatly diluted ethanolic solution that involves three active agents: silane, PA, and disulfide. Therefore, it has the supremacy of carrying multiple reagents in a single bottle which can treat different restorative material surfaces in the same manner. When applied to the surface, a layer with the proper active monomer is composed, which makes the hydrophilic surface a hydrophobic one ensuring efficient wetting of the restorative surface with the bonding agent. Then the surface is air blowed to get rid of the excess monomer and the solvent.[46]

Ebert et al analyzed the bond strength of both MB and CB bonded to various restorative dental material surfaces using a universal bonding agent (Monobond Plus, IvoclarVivadent). They concluded that Monobond Plus can produce strong bonds between both metal or ceramic brackets and all restorative material types used.[46]

## Conclusion

There are different methods for surface treatment of porcelain prior to orthodontic bonding. According to this review the most suitable less destructive method to the porcelain following debonding is using 37% PA followed by silane application as it can produce clinically accepted bond strength as proved in the literature. Yet, continuous development of new surface treatment methods and materials is highly important

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