# MORPHOLOGICAL CHANGES IN THE ENAMEL THAT AFFECTS THE BONDING OF BRACKETS: A REVIEW


## ABSTRACT

A literature review on the existing information about bonding of orthodontic brackets on altered enamel surfaces, the influence of such surfaces on adhesion, and the most favorable conditions for achieving better bond strength is presented. Studies on bracket adhesion have identified the conditions that lead to morphological changes in enamel as dental fluorosis and dental bleaching. In this review, each of these conditions that alter the enamel surface and pose a major challenge to clinical orthodontists performing bracket bonding, will be analyzed. The literature provides a range of approaches for overcoming the challenges of bonding on altered enamel surfaces and will be discussed, taking into account, where possible, the type of adhesive selected. Adhesion on enamel that is fluorosed depends on the degree of severity and the bond strength on a bleached enamel surface depends largely on the concentration of the bleaching agent.



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## KEYWORDS

Adhesives. Orthodontic brackets. Tooth bleaching. Fluorosis. Dental enamel.



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| **Received** 02 Jul 2015 **Received in revised form** 07 Jul 2015 **Accepted** 12 Jul 2015

## INTRODUCTION

Bonding systems are employed by dentists worldwide and are indispensable in bonding of orthodontic brackets to dental enamel[1] and for that reason, orthodontists have sought single-step, reliable, stable, and cost-effective adhesion systems. They should be able to promote successful bonding on the surface of the compromised enamel in a moist environment and should have adequate immediate bond strength that is maintained throughout the treatment. In addition, the adhesion should promote quick and easy debonding, without damage or micro-fractures on the surface of the enamel, and result in a surface-enamel resin with minimum resin content, which is fast- and easy-to-clean and polish.[2]

The advent of more refined adhesives could benefit orthodontists in clinically challenging situations, such as adhesion to enamel with dental fluorosis, hypoplastic and hypomineralised enamel, and enamel surface with defects and opacities.[2]

Another alteration on the enamel surface comes from dental bleaching. Many bleaching products and techniques are available to consumers without the supervision of professionals. Some can start an orthodontic or restoring treatment soon after dental bleaching.[3] Consequently, it is important that the orthodontist understands if bleaching may affect the adhesion of orthodontic brackets on the surface of the enamel.[4]

It is known that repetition in bracket bonding is time consuming and has a negative effect on the success of the orthodontic treatment,[5,6] delaying its progression. However, few studies have been conducted on the effectiveness of adherence to these types of altered dental substrates.[7]

Thus, this study aimed to present a literature review of the existing information regarding the adhesion of brackets on altered enamel surfaces and the effect of such surfaces on adhesion. Additionally, the factors influencing bonding to these surfaces and the options for achieving a better bonding are pointed out.

## LITERATURE REVIEW

*FLUOROSIS:*

Fluorosis is a hypermineralisation of the enamel characterized by a larger surface and porous subsurface than normal, and is a result of excess fluoride ingested during the enamel formation period.[6,9] The severity of dental fluorosis depends on the timing and duration of the overexposure to fluoride, the individual response, weight, degree of physical activity, nutritional factors, and bone growth.[6]

Fluorosed enamel is characterized by an outer hypermineralized, acid-resistant surface, with retention of more porous enamel in the areas of subsurface hypomineralization.[10] It

manifests as a white or brown discoloration occurring as pits, striations, or white opaque lines, leading patients to use composite or laminate veneers as an aesthetic resource after orthodontic treatment.[2]

The severity of fluorosis varies from mild to severe,which is correlated with the amount and duration of fluoride ingestion during dental development.[11,12] With the increase in severity, the enamel sub-surface becomes highly porous and the damaged sub-surface extends to the interior of the enamel.[7]

Orthodontists working in regions with endemic fluorosis face difficulties in bonding of brackets to fluorosed teeth.[5] In a clinical situation, debonding of brackets from fluorosed teeth because of stress, can occur as soon as they are positioned

The fluorosed enamel may be more resistant to acid, resulting in a decrease in the bonding of orthodontic accessories.[13] During debonding, due to increased porosity, the physical strength of enamel can bealtered resulting in damage to enamel, especially when there is stronger bonding in some areas of the teeth.[2]

Fluorosed teeth have an outer layer of hypermineralized enamel resistant to acid that varies between 50 to 100 μm in depth, and an extensively hypomineralized subsurface.[14] This hypermineralized surface results in altered patterns on the surface of the enamel after etching with 37% phosphoric acid, and consequently, becomes unsuitable for orthodontic adhesion.

Some researchers[15,16]recommend extending the duration of acid etching of fluorosed enamel in order to remove the hypermineralized acid resistant surface and increase bonding. In contrast, others report no differences in bonding between fluorosed and normal enamel when using different durations of acid conditioning. [17]

Another reliable method to obtain better adhesion is grinding the dental surface. Ermis et al.[7] (2007) assessed the effect of grinding the surface of the enamel on the effectiveness of conventional and self-etching adhesive on severely fluorosed enamel (grade 5), and observed that for both adhesives tested, the adhesive strength of unworn fluorosed enamel was significantly lower than that of ground enamel. They concluded that preparation of fluorosed enamel improves adhesion and that with self-etching, the bonding effectiveness to unground enamel is lower in fluorosed enamel than normal enamel.

The adhesive strength is reduced when using self-etch adhesive with no grinding on severe fluorosed surfaces[7] and smooth to moderate surfaces.[18] Swift[12] (2009) suggested conditioning the surface with phosphoric acid before applying the self-etch adhesive, thus ensuring an increase in compliance of the enamel. Gungor et al.[19] (2009) found

satisfactory bond strengths with self-etching adhesive surfaces on fluorosedenamel and low bond strengths with a standardetching protocol, i.e. using 37% phosphoric acid for 30 s. Ng'ang'a et al.[17] (1992) observed that the use of 40% phosphoric acid for 60 s, in grade 4 fluorosed enamel, conferred to the surface several etching patterns similar to normal enamel, and may be suitable for orthodontics.

With regard to the effect of an impaired fluorosed surface on bonding strength, there are reports that the adhesion is the same regardless of the severity.[10] However when comparing standard adhesive and self-etching systems, there is a decrease in the bond strength when self-etching systems are used in areas of moderate and severe enamel fluorosis. [10,12]

The adhesive systems can be used to increase the bonding strength in fluorosed enamels. Adanir et al.[5] (2009) compared the bond strength of grade 4 fluorosed enamel, with or without an adhesion promoter. They observed that the adhesive system increases the bond strength with fluorosed enamel, as reported in the study by Noble et al. [20] (2008).

To increase the adhesion of brackets on fluorosed enamel surfaces, Noble et al.[21] proposed to increase the conditioning time, use adhesive systems, and perform microabrasion of the surface, or a combination of these methods.

*TEETH BLEACHING:*

The most common forms of dental bleaching are home dental bleaching and in-office bleaching.[22] Little is known of the biological and physical effects of bleaching, particularly its effects on restorative materials and the shear bond strength of orthodontic adhesives to human enamel subjected to dental bleaching.[4]

Bleaching products can be used before or after orthodontic treatment.[23] The effect of bleaching on the morphology of the enamel surface and the bond strength between the resin and bleached enamel,and the post-bleaching effect are still controversial issues in the literature.

There are studies showing changes in the structure of the enamel and the composition and strength of the bond when exposed to 35% hydrogen peroxide. [24-26] This probably occurs because the residual oxygen from the bleaching agent inhibits the polymerization of compound resin.[27-30] Some authors[27,28] observed changes in enamel morphology after bleaching,including loss of prismatic format and changes on the surface of the enamel structure, which reduces the amount of resinous extension in the hybrid layer and the bond strength.

The reduction in bond strength may be due to loss of prismatic formation, loss of calcium and reduction in surface microhardness, interference of the residual

oxygen with penetration of the resin into the enamel, or inhibition of polymerization.[31-33] Several methods have been proposed to reverse the reduction of bond strength, including the removal of the outer enamel surface, delay in the adhesion procedure,[34] surface treatment with antioxidants, [27,30,35,36] use of alcohol-based bonding agents, or pretreatment of the surface with alcohol.[37]

Lower concentrations of bleaching agent, which are generally used in home dental bleaching, lead some authors to believe that the carbamide peroxide does not affect the bond strength of the bracket to the dental structure.[3,23] However, some studies show a reduction of the bond strength of the bracket when bonding is immediate, i.e., post-bleaching[45] or when self-etching adhesives are used.[34]

There is also no consensus in the literature regarding the influence of bleaching on adhesion on dental surfaces brightened with higher concentrations of bleaching agent, 35 to 38% hydrogen peroxide, used in bleaching of vital teeth by clinicians. Uysal et al.,[4] (2003), Mishima et al.[38] (2009) and Rao et al.[8] (2010)did not observe any influence of the bleaching agent at high concentrations on the adhesive strength of brackets when phosphoric acid, adhesive, and/or composite resin was used. However, Ozoe et al.[39] (2012) observed that the bond strength of brackets were lower when self-etching systems and immediate post-bleaching bonding were employed.

It is important that more studies assess self-etching adhesive systems. These have emerged with the aim of simplifying the procedure and reducing the time spent in orthodontic adhesion by omitting adhesive steps.[34] According to the same authors, the self-etching adhesive systems are easy to handle and apply, resulting in comfort to the patient, and may reduce the working time by up to 65%.

Several studies have analysed the post-bleaching period necessary for the bonding of brackets.[3,4,8,23,34,39-41] Bulut et al.[41] (2006) reported a reduction of bond strength when bonding was immediately after the dental bleaching. Ozoe et al.[39] (2012) observed the same result with self-etching adhesive. Others found[3,4] no influence of time post-bleaching on the adhesive strength of brackets. However, Bishara et al.[3] (2005) believe it prudent to postpone the bonding of brackets for at least two weeks post-bleaching, especially when using bleaching agents that are more aggressive.

One of the ways to speed up the release of residual oxygen of the dental structure is to use antioxidant agents, such as 10% solution of sodium ascorbate for 10 min with constant stirring.[30,35,36,42] The sodium ascorbate solution is neutral, biocompatible, and antioxidant; however, in clinical conditions, its application

is difficult due to its fluidity.[36] When applying on more than one tooth, the use of hydrogel form with a brush can be easier and more comfortable for both the patient and the clinician.

Bulut et al.[41] (2006) evaluated the effect of this solution and observed that using it or bonding the brackets one week bleaching, reverses the reduction in adhesive strength.

Desensitizing can be used during the bleaching treatment. Türkkahraman et al.[43] (2007) concluded that bleaching and desensitizing significantly affect the adhesion of brackets and therefore, suggested that these procedures be performed after the orthodontic treatment.

According to Ozdemir et al.,[40](2013) enamel etching may be performed by acid, laser,or sandblasting. The authors evaluated the bond strength of orthodontic brackets of bleached enamel surfaces with or without 38% hydrogen peroxide, prepared for adhesion with acid etching and Er:YAG laser. The conditioning with laser-bleached teeth resulted in similar bond strength values, but not identical, to those obtained on non-bleached surfaces. However, in the laser-conditioned groups, the bond strength after three weeks had the same values as the non-bleached group. They concluded that phosphoric acid etching is preferable when there is a need for immediate bonding in teeth bleached with 38% hydrogen peroxide.

## CONCLUSION

The changes on the enamel surface, due to fluorosis or dental bleaching, influence the adhesion of orthodontic brackets.

In fluorosed enamel, the adhesive strength may be affected by the severity of fluorosis, by use of grinding, duration of acid etching, the use (or not) of adhesives, and the type of adhesive system chosen. The use of adhesives can increase compliance in fluorosed enamel. The severity of fluorosis affects bonding to a higher degree when a self-etching adhesive is used. Grinding has little effect on conventional adhesives. The use of phosphoric acid before the application of self-etching primer adhesive system, and the increase of the conditioning time when using the conventional adhesive system, may improve adherence on fluorosed enamel.

The bond strength on bleached enamel is influenced by the bleaching agent only when self-etching adhesives are used. The post-bleaching period for bonding brackets does not seem to affect the bonding; however, await of at least two weeks is recommended. The use of antioxidants is a viable alternative to reduce the waiting time for bonding. Desensitizing and the use of laser to condition the surface reduce the bond strength.

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