Original Article

In Vivo Bonding of Orthodontic Brackets to Fluorosed Enamel using an Adhesion Promotor

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ABSTRACT

Objectives: To determine the success of bracket retention using an adhesion promoter with and without the additional microabrasion of enamel.

Materials and Methods: Fifty-two teeth with severe dental fluorosis were bonded in vivo using a split-mouth design where the enamel surfaces of 26 teeth were microabraded with 50 μm of aluminum silicate for 5 seconds under rubber dam and high volume suction. Thirty-seven percent phosphoric acid was then applied to the enamel, washed and dried, and followed by placement of Scotchbond Multipurpose Plus Bonding Adhesive. Finally, precoated 3M Unitek Victory brackets were placed and light cured. The remaining teeth were bonded using the same protocol but without microabrasion.

Results: After 9 months of intraoral service, only one bond failure occurred in the control group where microabrasion was used. Chi-square analysis revealed $P = .31$, indicating no statistical significance between the two groups.

Conclusions: Bonding orthodontic attachments to fluorosed enamel using an adhesion promoter is a viable clinical procedure that does not require the additional micro-mechanical abrasion step.

KEY WORDS: Fluorosis; Bonding; Adhesion promoter; Microabrasion

INTRODUCTION

Bonding brackets to fluorosed teeth remains a notable clinical challenge because of frequent bracket failure at the compromised enamel interface. The fluorosed enamel surface challenges orthodontists even more than bonding brackets to gold, amalgam, and porcelain.[1]

Fluorosed enamel demonstrates an outer hypermineralized and acid-resistant layer, where it is difficult to attach bonds because a reliable etched enamel surface cannot be produced.[2] Fluorosis manifests itself as defects in the subsurface enamel, ranging in color from white to brown and occurring as pits and irregular white opaque lines, striations, or cloudy areas, which further exacerbate the problem of bonding to the enamel. This also poses an esthetic dilemma, and such patients often receive composite or laminate veneers. Restorative dentists have also found bonding to fluorosed teeth to be problematic.[3]

Scanning electron microscope studies have confirmed that the difficulty in bonding is likely attributable to the inability of fluorosed enamel to be effectively etched with 37% phosphoric acid,[4–6] which results in a decreased amount of enamel irregularity, preventing effective bonding. These studies demonstrate that it is difficult to predict how a fluorosed tooth will be etched. Clinicians have therefore frequently relied on micromechanical etching of fluorosed teeth to attain a roughened surface.

It has been suggested that microabrasion of fluorosed enamel concomitantly with acid etching improves bond strength.[1,6] However, drawbacks to microabrasion include damage to enamel, the need to use a rubber dam, poor powder control, patient ingestion of the powder particles, the potential for the powder aerosol to cause facial trauma, increased chair time and costs, and potential allergy to the aluminum oxide or silicone carbide powder.[1]

An alternative method of bonding to fluorosed teeth is the use of an adhesion promoter. This allows the clinician to use a chemical dimension during bonding,

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which may be more predictable. An adhesion promoter consists of the primer, which is an aqueous solution of hydroxyl ethyl methacrylate (HEMA) and a polyalkenoic acid, which is thought to assist with moisture control. The primer allows the subsequent resin layer to flow or "wet" the etched surface. The adhesive is a bisphenol A diglycidylether methacrylate (Bis-GMA) and HEMA resin combined with a blend of amines, which can provide a fast, 10-second cure when activated by a visible light–curing unit. The chemical adhesion to enamel thus produced is claimed to result in less microleakage and a superior hermetic seal.

In an in vitro study by Ngan,[7] 26 fluorotic teeth classified as mild to moderate were bonded, and the researchers found that using Concise composite resin produced adequate bond strengths for orthodontics. They found that bond failure occurred primarily at the bracket-adhesive interface. They did not use an adhesion promoter, and they did not include teeth with severe fluorosis.

Currently, the literature describes only one clinical study of bonding orthodontic attachments to fluorosed teeth. Duan et al[8] reported a statistically significant decrease in bond failure when a light-cured resin veneer was placed on the teeth before bonding the orthodontic attachments. However, bonding the veneer itself may present difficulties and requires the removal of enamel. Furthermore, the time required to bond the veneer and the cost of the veneer and replacing it once orthodontic treatment is complete make this an expensive and less than ideal practice.

No studies could be found in the literature that clinically assess the reliability of bonding orthodontic attachments directly to fluorosed enamel in the presence of an adhesion promoter. Similarly, no studies could be found where microabrasion of enamel and an adhesion promoter were combined.

Objectives

Our prospective study is aimed at determining if microabrasion is a necessary step for bonding orthodontic brackets to fluorosed teeth in vivo or if an adhesion promoter can be used instead. If viable, it will help orthodontists achieve a more efficient and effective solution to the challenge of bonding to fluorosed teeth.

MATERIALS AND METHODS

Three patients (two girls, one aged 11 years 0 months and one aged 11 years 9 months, and one boy aged 14 years 4 months) representing 52 permanent fluorosed teeth with severe dental fluorosis, according to Dean's modified indices for classifying dental fluorosis[9,10] (Figure 1) were used in this prospective clinical study.

Figure 1. Intraoral photograph of one of the study patients with severe dental fluorosis.

The 52 permanent teeth were bonded using a split-mouth design with the following protocol:

- All teeth were polished with a pumice and water slurry.
- The control group was represented by teeth in quadrants 1 and 3 of patients A and C and quadrants 2 and 4 of patient B (26 teeth in total) and were microabraded with 50 μm of aluminum silicate for five seconds under rubber dam isolation and high volume suction (Figure 2).
- A dry field was obtained using the Nola™ dryfield system (Dentsply, York, PA).
- Thirty-seven percent phosphoric acid (Dentsply Caulk) was then placed on the air-abraded enamel surface with a syringe applicator for 30 seconds.
- The etchant was thoroughly washed with water for 10 seconds followed by air-drying for 10 seconds with a three-inch chair-side syringe with compressed air.
- An adhesion promoter, Scotchbond Multipurpose Plus Primer (3M Unitek, Monrovia, CA) was applied and gently air dried for 5 seconds, followed by light

Figure 2. Rubber dam in place with high-volume suction during microabrasion.

curing for 10 seconds with a visible white light unit (Blue Ray, American Orthodontics).
— 3M Unitek Victory APC (adhesive precoated system, Monrovia, CA) brackets were placed and light cured for 60 seconds.
— The same protocol was undertaken for quadrants 2 and 4 in patients A and C and quadrants 1 and 3 of patient B, but the microabrasion step was omitted. These teeth formed part of the experimental group.

Patients were followed up at 4–6 week intervals. Each bracket was checked at each appointment for full or partial debond, microleakage, or decalcification by visual means. Hygiene status was monitored at each visit. Patients with loose brackets were questioned as whether it occurred as a result of a traumatic incident, such as chewing on hard candy. Patients were also advised to call the clinic as soon as any orthodontic bracket debonded and to retain the bracket if it detached from the archwire.

RESULTS

After 9 months of intraoral service with a progression of archwires from round nickel titanium to rectangular stainless steel, only one bond failure occurred in the control group where micromechanical abrasion was used in the bonding protocol. This failure occurred at the resin-tooth interface of the lower left lateral incisor. This occurred 4 days after initial bonding. Upon questioning the patient, this debond did not occur because of a traumatic incident. It was also clear that the upper incisal edge was not impinging on the lower incisor bracket either.

Chi-square analysis revealed $P = .31$, indicating no statistical significance between the control and experimental groups at the 9-month period.

Hygiene status was maintained to an acceptable standard by all patients at each visit, and no significant amount of plaque was found around brackets. There was no evidence of microleakage or decalcification around any brackets.

DISCUSSION

Clinical evidence of this prospective clinical investigation of bonding to 52 severely fluorosed teeth in vivo indicates excellent clinical retention for both the experimental and control teeth. Therefore, bonding orthodontic attachments to fluorosed teeth using enamel etching in conjunction with chemical bonding via an adhesion promoter (Scotchbond Multipurpose Plus Bonding Adhesive, 3M Unitek, Monrovia, CA) appears to be a viable clinical procedure without an additional micromechanical abrasion step.

Nine-month clinical outcomes indicate that the use of an adhesion promoter is an alternative to pure reliance on micromechanical retention when bonding to compromised enamel surfaces in orthodontics. Chemical bonding gives the added benefit of a hermetic seal, which prevents microleakage around bracket bases.

If bond failure were to occur because of a poor bonding potential to compromised enamel, it would normally happen in the first few days or weeks after bonding. The longevity of bracket retention for the remainder of treatment in our study has a good prognosis, as we have surpassed the 9-month in-service period.

Avoiding the need for microabrasion results in the preservation of enamel, prevents a roughened enamel surface adjacent to the bracket, avoids potential hazards from microabrasive powder, and allows for a bonding appointment that is more time-efficient, less complicated, and more comfortable for the patient and the orthodontist.

Adhesion promotion heralds new and improved options for orthodontists when dealing with the clinical dilemma of bonding to fluorosed and hypocalcified enamel. The results of this prospective clinic study have provided encouraging clinical evidence of bonding to fluorosed teeth with adhesion promoters.

CONCLUSIONS

- Use of an adhesion promoter provides a clinically successful adhesive bonding protocol of orthodontic brackets to severely fluorosed human teeth.
- This negates the need for microabrasion as a method to increase micromechanical orthodontic bracket retention.

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