EFFECT OF CPP-ACP AND APF APPLICATION ON SHEAR BOND STRENGTH OF BRACKETS BONDED ON BLEACHED ENAMEL

ABSTRACT

Background and Aim: To compare the shear bond strength (SBS) and debonding failure modes of brackets luted to untreated enamel and bleached enamel treated with casein phosphopeptide-amorphous calciumphosphate (CPP-ACP) and/or acidulated phosphate fluoride (APF).

Materials and Methods: Sixty-six human premolars were randomly divided into 6 groups (n=11) as follows: 1: No pre-treatment of enamel (control); 2: Enamel treated with 37.5% hydrogen-peroxide office bleaching agent; 3: Enamel treated with CPP-ACP for 3 minutes after bleaching; 4: Enamel treated with APF for 4 minutes after bleaching; 5: Enamel treated with APF for 4 minutes and CPP-ACP for 3 minutes after bleaching; 6: Unbleached enamel treated with APF for 4 minutes and CPP-ACP for 3 minutes, respectively. Brackets were bonded using a conventional bonding system. Bonded specimens were subjected to thermal cycling for 1000 cycles. The specimens were tested in shear with a universal testing machine. Teeth and brackets were examined under a stereomicroscope at 16X magnification to see whether any adhesive remained in accordance with the modified adhesive remnant index (ARI). Comparisons of SBS values were made with the Kruskal-Wallis test. Fisher’s exact test was used to determine the differences in the ARI scores.

Results: There were no significant differences in the SBS (P = 0.359) and ARI scores (P = 0.175) between groups.

Conclusion: SBS of brackets was not adversely affected by bleaching and application of CPP-ACP and APF. CPP-ACP, APF and combined application of both may be safely used before orthodontic treatment in patients with tooth bleaching history.

Keywords: Casein Phosphopeptide-Amorphous Calciumphosphate, Acidulated Phosphate Fluoride
Sorumlu Yazar
Banu Sağlam-Aydınatay

ÖZ
Amaç: Bu çalışmanın amacı beyazlatma uygulanmış ve uygulanmamış dişlerde kazein fosfopeptit amorf kalsiyum fosfat (CPP-ACP) ve/veya asidüle fosfat florid (APF) kullanımının ortodontik braketlerin kesme tipi kuvvetlere karşı bağlanma dayanımı (SBS) ve kopma türü üzerindeki etkilerini değerlendirmektir.

Materyal ve Metod: 66 adet insan premolar dişi rastgele olarak 6 gruba (n=11) ayrıldı: 1: Mineye herhangi bir işlem uygulanmadı (kontrol); 2: Mineye %37.5 hidrojen-peroksit ofis tipi beyazlatma ajanı uygulandı; 3: Beyazlatma sonrası mineye 3 dakika CPP-ACP uygulandı; 4: Beyazlatma sonrası mineye 4 dakika APF uygulandı; 5: Beyazlatma sonrası mineye 4 dakika APF ve 3 dakika CPP-ACP uygulandı; 6: Beyazlatma yapılmamış mineye 4 dakika APF ve 3 dakika CPP-ACP uygulandı. Braketler konvansiyonel bir adeziv sistem kullanılarak yapıştırıldı. Örnekler koparma işlemleri öncesinde 1000 devir boyunca termal siklusa tabi tutuldu ve daha sonra koparma testi uygulandı. Dişler ve braketler X16 büyüme ile stereomikroskop altında incelendi ve modifiye adeziv kalıntı indeksi (ARI)'ne göre sınıflandırıldı. SBS değerleri Kruskal-Wallis kullanılarak karşılaştırıldı. ARI skorları arasındaki farklar Fisher's exact testi ile değerlendirildi.

Bulgular: Gruplar arasında SBS değerleri (P= 0,359) ve ARI skorları (P= 0,175) açısından istatistiksel olarak anlamlı bir fark bulunmadı.

Sonuç: Ortodontik braketlerin bağlanma dayanımı ofis tipi beyazlatma ve topikal CPP-ACP ve APF uygulamasından olumsuz olarak etkilenmedi. Beyazlatma hikayesi olan hastalarda ortodontik tedavi öncesinde CPP-ACP ve/veya APF güvenli olarak kullanılabilir.

Anahtar Kelimeler: Kazein Fosfopeptit Amorf Kalsiyum Fosfat, Asidüle Fosfat Florid

Yayın Başvuru Tarihi : 18.09.2014
Yayına Kabul Tarihi : 09.03.2015
INTRODUCTION

White spot lesion (WSL) formation around and under fixed appliances is still a major clinical problem during orthodontic treatment with a reported prevalence of 0-97%.1,2 Although WSLs might remineralize to some extent after debonding, complete regression is unlikely which may compromise the final aesthetic results of treatment.3,4 Due to prolonged treatment durations and the risk of poor patient compliance in maintaining proper oral hygiene, utilization of adjunct strategies have been suggested in recent decades to prevent or reduce decalcification in patients with orthodontic appliances.5

Fluoride have been used as an anti-caries agent in dentistry for over 50 years.6 When present in the tooth-oral fluids interface, fluoride inhibits demineralization and enhances remineralization of the enamel through formation of calcium fluoride and fluorapatite.7 There is also some evidence that topical fluoride application before, during or after enamel etching may reduce WSL incidence during orthodontic treatment.8-12 However, the mechanism by which fluoride inhibits demineralization may negatively affect the bond strength of brackets by making enamel more resistant to acids.13 Some studies have reported that topical fluoride application reduces the bond strength of resin composite to enamel,14,15 whereas others demonstrated no adverse effects.10,16,17

Casein phosphopeptide-amorphous calcium phosphate (CPP-ACP), derived from bovine milk, is a new chemical agent which has been shown to prevent enamel demineralization and promote lesion remineralization in several studies.18-22 The anticariogenic potential of CPP-ACP is based on its ability to form a supersaturated mineral environment on dental plaque and tooth surfaces by releasing calcium and phosphate ions on acid challenge.23 It has been suggested that CPP-ACP, either alone or combined with fluoride, could be used as a prophylactic agent in orthodontic practice as it does not compromise bracket bond strength.24-27

Since tooth color is one of the most important factors in satisfaction with oral appearance,28 there has been an increasing demand for tooth bleaching among dental patients in recent years. It has been suggested that the whiter appearance of teeth after bleaching may result in increased awareness of other problems with dentition and a desire for further esthetic dental procedures, which may involve orthodontic treatment.29 Thus, it is important to determine whether the use of anti-caries agents on bleached teeth significantly effects the bond strength of orthodontic bracket to the enamel surface.

Therefore, this study aimed to compare the shear bond strength (SBS) of orthodontic brackets bonded to bleached and unbleached enamel topically treated with CPP-ACP and/or acidulated phosphate fluoride (APF).

MATERIAL AND METHODS

Sixty-six human premolars extracted for orthodontic purposes were collected. The criteria for tooth selection were intact buccal enamel without defects; no pretreatment with chemical agents, such as peroxide, acid or alcohol derivatives; no caries; and no restorations. After debride ment, the teeth were stored in deionized water at 4°C, which was renewed weekly. The maximum storage time for the teeth was 4 weeks. Each tooth was embedded vertically in self-cure acrylic until its cemento-enamel junction, leaving the crown exposed. The teeth were randomly divided into six groups (n=11): Group 1: Control group with no pretreatment of the enamel. Before the bonding procedure, the teeth were polished with nonfluoridated pumice (Moyco Industries, Philadelphia, Pa) for 10 seconds using a rubber prophylactic cup, rinsed with water for 10 seconds, and air dried. Group 2: In-office bleaching was performed using 37.5% hydrogen peroxide (Pola Office+; SDI Limited, Victoria, Australia), according to the manufacturer’s instructions. The bleaching gel was left on the labial surfaces of teeth for 8 minutes, and then suctioned off using a surgical aspirator tip. This procedure was repeated 3 times. After the last application, all the gel was suctioned off and the teeth were rinsed with water. The specimens were stored in deionized water at room temperature for three weeks. Before the bonding procedure, the teeth were polished with nonfluoridated pumice as described in Group 1.

Group 3: CPP-ACP (GC Tooth Mousse; GC Europe, Leuven, Belgium) was applied with a brush and left for 3 minutes.

Group 4: 1.23% APF (Gelato APF Gel; Deepak Products, Miami, FL, USA) was applied with a brush and left for 4 minutes.

Group 5: 1.23% APF was applied for 4 minutes and CPP-ACP was applied for 3 minutes, respectively.

Group 6: No bleaching was performed. After polishing with
nonfluoridated pumice as described in Group 1, the enamel was treated with 1.23% APF for 4 minutes and CPP-ACP for 3 minutes, respectively. After the surface treatment, the residual mousse or gel was wiped off with gauze. The enamel surfaces were etched with 38% phosphoric acid etching gel (Etch-Rite; Pulpdent Corporation, Watertown, MA, USA) for 20 seconds, rinsed with water for 15 seconds and dried with oil-free compressed air for 10 seconds until a chalky white appearance was obtained. Orthodontic metallic premolar brackets (Generous Roth Brackets; GAC International Inc., Islandia, NY, USA) with an average base area of 12.13 mm² were bonded to the teeth using a conventional bonding system (Transbond XT; 3M Unitek, Monrovia, CA, USA) according to the manufacturer's instructions. A thin coat of primer (Transbond XT Primer; 3M Unitek, Monrovia, CA, USA) was applied on each tooth surface to be bonded. The adhesive was placed on the base of the bracket and then the bracket was positioned and pressed firmly on the buccal enamel surface. Excess adhesive was removed with a scaler and the adhesive was light cured for 20 seconds from the mesial and distal sides of the brackets, respectively. A LED LCU (Elipar Free Light; 3M ESPE, St Paul, MN, USA) was used for light curing. After bonding, all samples were stored in deionized water at 37°C for 48 hours, and then subjected to thermal cycling for 1000 cycles at 5°C to 55°C, with a dwell time of 30 seconds each. The samples were then stored for 4 weeks in deionized water before debonding procedures. The shear bond strengths were measured using an universal testing machine (Zwick Test Machine; Zwick GmbH & Co, Ulm, Germany). An occlusogingival load was applied to the bracket at a crosshead speed of 1 mm/min. The force required to debond the bracket was recorded in newtons (N) and the SBS values were calculated in megapascals (MPa) by dividing the force by the area of the bracket base. Mode of debonding failure was determined by examining the specimens at x16 magnification under a stereomicroscope (Leica MS5; Leica Microsystems (SEA) Pte Ltd., Singapore, Singapore) and were classified according to the modified adhesive remnant index (ARI). Statistical analyses were performed using Statistical Package for Social Sciences Inc. (SPSS version 15.0 for Windows, Illinois, USA). The data set was non-normalized so the Kruskal-Wallis test (followed by Dunn's post-hoc test) was used to ascertain whether significant differences existed between the SBS of the groups. Fisher's exact test was used to determine significant differences in the ARI scores among the groups. The level of significance was established at P< .05 for all statistical tests.

RESULTS

The descriptive statistics for the SBS values of the groups are shown in Table 1. Even though the SBS values in the experimental groups were lower than those of the control group, there were no statistically significant differences between the bond strengths among the groups (P= 0.359). Further analysis with Dunn's multiple comparisons test did not reveal any statistical differences among the six groups (P>0.05 for all). The frequency distribution of ARI scores of the 6 groups is presented in Table 2. There was a predominance of score 4 for Group 3 and score 5 for the other groups (Table 2). The results of Fisher's exact test revealed no significant differences among the groups regarding the mode of failure (P= 0.175). No enamel detachment was found in any of the groups.

DISCUSSION

Mechanical and chemical plaque control before bracket bonding procedure reduces the risk of caries formation and enamel demineralization during orthodontic treatment. Patients receiving orthodontic treatment are commonly prescribed various forms of fluoride as a preventive measure against enamel demineralization. In recent years, the use of calcium phosphate-based technologies have also been advocated to prevent demineralization and promote lesion remineralization. Bleaching is a conservative and economic procedure for the treatment of tooth discolorations. It is generally recommended that bleaching be performed after the removal of orthodontic appliances. However, due to professional or social needs, patients may have had their teeth bleached before orthodontic treatment. It has been reported that CPP-ACP applied before and/or after the bleaching protocol prevents negative changes in roughness and hardness associated with hydrogen peroxide in enamel. This action of CPP-ACP may interfere with the acid-etching process, affecting bonding to enamel. However, there is limited
evidence regarding the effects of combined use of CPP-ACP with bleaching agents on composite-enamel bonding. Adebayo et al. reported that bond strength to enamel with a total-etchant adhesive was not affected by bleaching and CPP-ACP application whereas Moule et al. found that combined use of carbamide peroxide and CPP-ACP significantly decreased shear bond strength of resin to enamel. To our knowledge, there are no published studies evaluating the comparative effects of CPP-ACP and APF on bond strengths of brackets bonded to previously bleached teeth. Thus, we designed this study to see if the use of a CPP-ACP paste and/or APF as prophylactic agents before bracket bonding on hydrogen peroxide bleached teeth affects the shear bond strength of orthodontic brackets. It has been suggested that residual oxygen within the bleached tissues may be responsible for poor resin polymerization and increased resin porosity. Delayed bonding of teeth for up to 3 weeks has been recommended to overcome the adverse effects of any residual oxygen and achieve optimal bond strengths. In our study, the elapsed time between the bleaching procedure and bracket bonding was 3 weeks. Under these conditions, bleaching with 37.5% hydrogen peroxide did not significantly affect the SBS of brackets. However, the mean SBS value for the bleaching group was 1.8 MPa lower than that of the control group.

Studies on the effects of CPP-ACP and/or APF application before bracket bonding on SBS of orthodontic brackets have provided contradictory results. Kecik et al. reported that pretreatment of the enamel with CPP-ACP and/or APF significantly increased the SBS of brackets whereas Tabrizi and Cakirer found that while application of fluoride varnish alone reduced the bond strength of brackets, the use of CPP-ACP alone or with fluoride did not affect SBS. In contrast with these results, Cehreli et al. found a reduction in bond strength with CPP-ACP application. It has also been shown

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<th>Table 2. The frequency and percentage distribution of Adhesive Remnant Index (ARI) scores among groups</th>
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P = 0.359

P = 0.175
that CPP-ACP and fluoride application on demineralized enamel surfaces increases SBS of brackets. In our study, pretreatment with CPP-ACP and/or APF decreased the SBS of brackets and the lowest bond strength was found in Group 4 (SBS = 13.9 ± 4.3 MPa) where bleached teeth were treated with APF. However, these differences were not statistically significant and the bond strength values were higher than the suggested minimum bond strength of 6-8 MPa which was reported to be adequate for orthodontic clinical use by Reynolds. These results indicated that SBS of orthodontic brackets was not adversely affected by bleaching and application of CPP-ACP and APF in vitro. However, limitations of in vitro studies should be considered while interpreting these results for clinical use. Failure at the bracket-adhesive interface has been suggested to be more desirable to prevent enamel damage. However, another opinion supports bond failure between enamel and adhesive so that there will be less adhesive residue to remove at the time of debonding. The ARI scores in this study were not significantly different between the groups. The predominant mode of failure was at the enamel-adhesive interface which is in agreement with other studies. Despite high ARI scores, no enamel detachment was found in any of the teeth. There are some limitations to the current study. Although the results of our study lets us better understand the effects of these preventive products on bond strengths of brackets, in-vitro experiments cannot create all the conditions of the oral environment. Another limitation is the relatively small sample size in the groups. Further larger studies or controlled clinical trials are needed to confirm these results.

CONCLUSIONS

Within the limitations of this study, it can be concluded that the application of a CPP-ACP paste and/or 1.23% APF gel did not adversely affect the SBS of orthodontic brackets bonded 3 weeks after 37.5% hydrogen peroxide in-office bleaching. Either or both of these preventive agents can be used for prophylaxis against white spot lesions during orthodontic treatment in patients with prior tooth bleaching history.

REFERENCES


