

CHALLENGES OF USING TRANSBOND PLUS IN ORTHODONTIC TREATMENT

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ABSTRACT

Aim of the study. This *in vitro* study aimed to investigate the shear bond force created by Transbond Plus Color Change and Transbond Self-Etching Primer in different conditions of the primer's application and for different durations of light-curing the bonding agent. **Material and methods.** The study sample consisted of 48 premolars extracted for orthodontic purposes. The teeth were divided into four groups each one of 12 premolars then the brackets were bonded in each group by different procedures: in groups 1 and 2 by the classical application of the primer followed by the light-curing of the bonding agent for 20 and 40 seconds, respectively. In groups 3 and 4 the primer was light-cured then the bonding agent was cured for 20 and 40 seconds, respectively. We used a universal testing machine for detaching the brackets and determined the SBS's values. **Results.** The mean SBS's values in groups 1, 2, 3 and 4 were 12.23, 15.93, 15.35 and 18.49. We found statistically significant differences between groups.

Keywords: shear bond strength, primer's application, light-curing duration

INTRODUCTION

The issue of adhesion of orthodontic brackets is a constant concern of researchers [1,2]. The introduction of light-curable bonding agents on the market has been a great technological advance [3]. Compared to self-curing adhesives, in which the dosage of the components often allowed quantitative errors and variations in the quality of the final material or a non-homogeneous preparation, light-curing adhesives give easy and precise handling and fixing of brackets, shortening of the working time [3].

The manufacture of color-change light-curing adhesives has been a great help for clinicians; by the fact that the excess adhesive

which has a different color from the enamel before polymerization can be removed, it is possible to further clean the areas around the brackets that otherwise predispose to the formation of caries, demineralization, permanent staining of the enamel due to prolonged retention of food coloring and mechanical irritation of soft tissues [4,5].

Transbond Plus Color Change Adhesive TPCC (3M Unitek, Monrovia, CA, US) is an adhesive widely used in our country, being preferred by many orthodontists because of its characteristics: the initial pink color different from that of enamel allows easy cleaning of the bonding material after fixing the brackets, before polymerization. The glass-ionomer

particles added in the resin structure give it a carioprophylactic effect, also preventing the demineralization of the enamel. TPCC is described by the manufacturer as having hydrophilic properties [4]; it is suitable for both metal and ceramic brackets [5].

Nowadays, primers are used to create adhesion between dental tissues and composite resins. The self-etching primers contain adhesive acids and resins in a combination that has the role of improving adhesion and reducing the working time. The primers create a layer between the etched enamel and the resin monomers which form polymer chains by light-curing [6]. Transbond Plus Self-Etching Primer TSEP (3M Unitek, Monrovia, CA, US) is indicated to be used as a primer for TPCC, by placing it on the enamel surface on which the bracket is to be put and rubbed there for ten seconds or fixed there for 10 seconds with a light jet of air from the unit's spray [7].

In discussing their clinical experience, the authors and other orthodontists reached a controversy: some clinicians believed that the 10 second light-cure of TSEP, like for a classic bonding agent, would provide greater adhesion power to brackets. At the same time, these practitioners said that by these procedures the brackets are difficult to detach at the end of the treatment, the force they have to use for debonding is so great that they fear the possibility of fracturing the enamel of the bonded teeth. Other orthodontists said that following exactly the application instructions of the primer and not light-curing it the adhesion of the brackets was better. Reynolds [8] demonstrated many years ago that in orthodontics the adequate bond strength would be between 6-8 MPa.

Higher adhesion values lead to enamel cracks and subsequent pulpal pathology at the time of the brackets' detachment [4,9]. There are studies that show a decrease in the shear bond strength's value when light-curing has been done for 20 seconds not for 40 seconds as normally indicated [10,11]. This variation has reduced the risk of pathologies that may occur due to SBS's values much higher than the indicated ones. In order to test the adhesion created by TPCC and TSEP and how it is influenced by the way that primer is applied and the time the bonding agent is light-cured we performed the following *in vitro* study.

MATERIAL AND METHODS

Our study was performed *in vitro*. The study group consisted of 48 premolars that had been previously extracted in order to treat orthodontic cases. Those patients agreed to the use of their teeth in the study. The teeth included in the study were examined with a magnifying glass to eliminate the possibility of the presence of decalcifications, decay or previous fillings. Subsequently, the selected teeth were cleaned with the handpiece of the dental unit, rubber cups and fluoride-free professional toothpaste [12]. The teeth were mounted in Duracrol cylinders, with the root completely included in the acrylic mass and the crown exposed for bonding brackets [13]. Then, we bonded Discovery brackets from DENTAURUM, Ispringen, Germany on the vestibular surfaces of the premolars. The bonding agent and the primer were cured with Demetron LC, SDS Kerr, USA, which has been described by having a light intensity of 800 mW/cm² [7]. The samples were randomly divided in 4 groups of 12 teeth each; the type of application of the primer is defined as

follows: **A** for the groups in which TSEP was not light-cured and **B** for the groups in which TSEP's photopolymerization was done for 10 seconds.

Adh A 20 : we first applied TSEP then for 10 seconds a fine jet of air from the dental unit spray; TPCC was put to the brackets' bases which were then bonded to the center of the vestibular surfaces of the premolars. Excess TPCC was removed with a sharp scaler. Light-curing was done for 20 seconds from the vestibular perspective, keeping the tip of the UV lamp at 3 mm from the bracket.

Adh A 40: we performed the brackets' bonding procedures exactly as in the first group but the light-curing was done for 40 seconds, from a cervical, occlusal, mesial and distal perspective for 10 seconds each; the tip of the UV lamp was placed at 3 mm from the bracket.

Adh B 20: the procedures were the same as in the first group, but after applying the primer it was light-cured for 10 seconds.

Adh B 40: we applied TSEP then the jet of air for 10 seconds; the primer was light-cured for 10 seconds. We bonded the brackets using TPCC in the same way as in the first group but the light-curing was done for 40 seconds, from a cervical, occlusal, mesial and distal perspective, 10 seconds each, keeping the tip of the UV lamp at 3 mm from the bracket.

In order to determine the shear bond force required for debonding we used a universal testing machine. The cervico-occlusal dimension of the crowns was parallel with the

shear load. The debonding force was applied at the interface between the bracket and the crown of the tooth with a speed of 0.5 mm/min. The shear bond strength SBS was expressed in megapascals (MPa) by the conversion of the forces produced at the moment of detachment of the brackets which were expressed in Newtons (N) [14].

Statistical analysis was performed with Graph Pad Prism V6 software. The results are expressed as the mean \pm standard deviation and the value of the median. The Kolmogorov Smirnov test was used to test the normality of the data. When the data were parametric the Student's t test was used for independent ones, otherwise and we used the Mann-Whitney test. The statistical significance level was $p < 0.05$.

RESULTS

Table 1 shows that the mean of the SBS's in group Adh A 40 is significantly higher than the mean of the SBS's in group Adh A 20. Group Adh B 40 has a significantly higher SBS's mean than group Adh B 20. **Table 2** shows that the mean of the SBS's in group Adh B 20 is significantly higher than the mean of the SBS's in group Adh A 20. There is no significant difference between group Adh A 40 and group Adh B 40 SBS's means. **Fig. 1** illustrates comparisons between group statistical means with the statistically significant differences between them.

Groups	Application type/Seconds	Mean \pm SD	P value
Group 1	Adh A 20	12.23 \pm 3.29	0.02
Group 2	Adh A 40	15.93 \pm 3.60	
Group 3	Adh B 20	15.35 \pm 3.21	0.04
Group 4	Adh B 40	18.49 \pm 3.61	

Table 1. Comparison between the same adhesive groups

Groups	Application type/Seconds	Mean±SD	P value
Group 1	Adh A 20	12.23±3.29	0.03
Group 3	Adh B 20	15.35±3.21	
Group 2	Adh A 40	15.93±3.60	0.11
Group 4	Adh B 40	18.49±3.61	

Table 2. Comparison between different adhesive groups

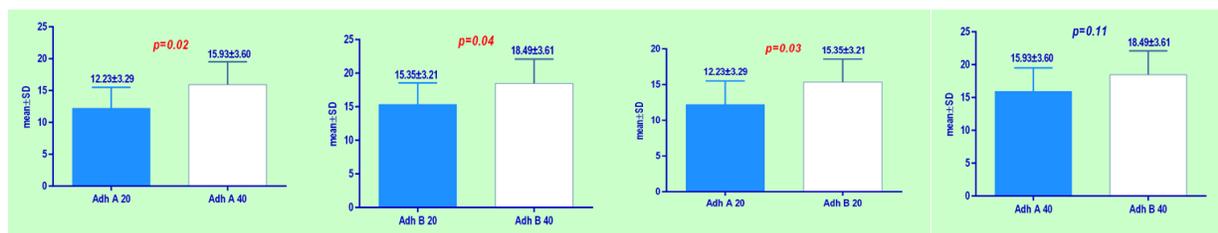


Fig. 1. Comparisons between group statistical means. Statistically significant differences

DISCUSSION

Although Reynolds argued that in orthodontics the acceptable adhesion values are 6-8 MPa [8], other authors believe that adhesion values above 13.5-14 MPa are too high and cause enamel fractures, this risk increasing as adhesion is higher [15,16]. Taking into account these values, we could say that only in the group in which the TSEP primer was applied according to the manufacturer's instructions, without UV polymerization and the light curing of the TPCC bonding agent was done for 20 seconds we got an adhesion within normal limits; the SBS of this group was 12.23±3.29 MPa. In all the other three studied groups SBS had too high values which, although they could give to the orthodontist the certainty that the brackets will not come off during the treatment, indicated the possible above mentioned issues at debonding. The highest SBS value was recorded by group 4, Adh B 40 and was 18.49±3.61 MPa. Adhesion increases statistically significant when the duration of

light-curing of the TPCC increases from 20 seconds to 40 seconds and it is performed from different directions regardless of how the primer was applied. By performing the same photopolymerisation time we found great differences between the groups in which the polymerization of the primer was done and the others; in the groups in which the light-cure was done for 20 seconds, the difference was significantly higher than in the group in which the TSEP was light-cured before bonding with TPCC.

Bayani et al. [7] investigated the adhesion of TPCC using the TSEP primer applied by the method we also used in the A groups: after brushing it on the enamel's surface they blew for 10 seconds a light jet of air. They light-cured TPCC for 20 and 40 seconds respectively, like we did in our study. The SBS test method was similar to the one we used; however, the SBS's values they found were higher than ours: 14.05±4.24 MPa in the group where the curing was done for 20 seconds and 19.64±3.76 MPa in the group

where the light-curing duration was 40 seconds. Even if they did not specify, we can assume that the differences between their SBS's values and ours come from the different way in which the polymerization was done: they may have used other incidences or may have positioned the tip of the UV lamp at a shorter distance from the brackets.

Türkkahraman et al. [17] determined the SBS's values of Transbond Plus as a bonding agent but used Transbond XT as a primer. TPCC photopolymerization was performed for 40 seconds, 20 seconds from the mesial and 20 seconds from the distal perspectives. The SBS's value was 16.0 ± 4.4 MPa. This value was very similar to the one we found in the group where we bonded brackets with TSEP as a primer and light-cured TPCC for 40 seconds but from 4 different perspectives - 15.93 ± 3.60 MPa. The SBS value was similar to ours even though the authors did the enamel etching with 37% phosphoric acid before applying the primer in addition to us.

Ekhlassi et al. [4] tested in time the adhesion created by using TSEP and TPCC for bonding brackets. The primer was prepared according to the manufacturer's instructions, checked and applied by rubbing it for 5 seconds on the enamel's surface; then a light jet of air was blown for 1-2 seconds. TPCC was cured for 5 seconds from each perspective, in total for 20 seconds. The test performed after 15 minutes showed a SBS value of 14.3, higher than the one determined by us in case of using TSEP without UV application and light-curing the adhesive for

20 seconds but from vestibular perspective. Probably the application of the UV lamp's tip from 4 different perspectives and the slightly different way of applying the primer were the reasons of the higher adhesion they found.

We did not find in the literature other studies which investigate the possibility of light-curing TSEP and the variations of the shear bond strength by its polymerization. This fact gives our study the element of uniqueness. It may be interested to evaluate in the near future the effects of lower photopolimerisation times.

CONCLUSIONS

When using Transbond Plus Color Change for bonding orthodontic brackets, adequate adhesion was obtained when the primer was used according to the manufacturer's instructions and the bonding agent was light-cured for 20 seconds. The light-curing of the primer and the extension of the curing time of Transbond Plus to 40 seconds increase the bond strength values beyond the clinically acceptable limits. Maximum SBS's mean value was determined when the primer was light-cured and the polymerization of the bonding agent was done for 40 seconds. For the future research studies it is important to investigate even by other parameters the adhesion between Transbond Plus Color Change and tooth enamel in different working conditions in order to be able to determine more precisely the better way to use it without harmful effects on tooth enamel.

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