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Original Research

Comparison of SBS of colour changing adhesives - Transbond Plus, Blugloo, Grengloo

Mohamed Rameez[1], Kiran. H[2], Rajkumar S. Alle[3], Bharathi. V. S[4], Dharmesh. H. S[5]

[1]PG student, [2]Professor, [3]Head of Department, [4]Associate professor, [5]Reader,
Department of Orthodontics and Dentofacial Orthopedics, Rajarajeswari Dental College, Bangalore, Karnataka, India

ABSTRACT:
Aim: The aim of the study is to compare and evaluate the shear bond strength of color changing adhesives Transbond Plus, Grengloo and Blugloo when contaminated with saliva. **Methodology:** One hundred and twenty premolars extracted for orthodontic purpose or due to periodontal involvement was collected, rinsed thoroughly and stored in 0.1% (wt/vol) thymol. The teeth were divided into three groups; group I- transbond plus, group II- grengloo, group III-blugloo. Each group was subdivided into: A. No Contamination, B. Contamination with saliva before application of bonding agent, C. Contamination with saliva after application of bonding agent, D. Contamination with saliva both before and after application of bonding agent. All teeth were mounted on the acrylic jig individually. The procedure of etching and priming of the teeth was carried out according to manufacturer's instruction. Contamination of the mounted teeth with artificial saliva was performed in the order of the above-mentioned categories. The metal premolar brackets were then bonded using color changing adhesives Transbond Plus (n=40), Grengloo (n=40), Blugloo (n=40). After 24 hours the brackets were tested for shear bond strength using a Universal Testing Machine. The results obtained were analysed with ANOVA test followed by Tukey's HSD post hoc Analysis. **Result:** The bonding performance of Grengloo and Blugloo was comparable. However, the bond strength of Grengloo and Blugloo was relatively higher than Transbond Plus. This may be due to the sealant, Ortho Solo, used in these groups. **Conclusion:** All three color changing adhesives can be used safely in orthodontic practice since they show acceptable bond strengths. Even though Transbond Plus showed acceptable bond strength during saliva contamination procedures, it was less than that of Grengloo and Blugloo. In situations where extra bond strength is needed, Grengloo and Blugloo may be preferred.
Key words: Adhesives, Transbond Plus, Grengloo, Blugloo.

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Corresponding author: Dr. Mohamed Rameez, Department of Orthodontics and Dentofacial Orthopedics, Rajarajeswari Dental College, Bangalore, Karnataka, India

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INTRODUCTION

The bonding system in orthodontics based on the acid-etching technique was introduction by Buonocore in 1955 and further modified by Newman and Retief et al during the 1960s for orthodontic purposes. The ideal requirements of orthodontic bonding adhesives are sufficient bond strength, ease of debonding, and no permanent damage to the enamel surface.[1,2,3]

Bond failures due to moisture contamination are common implications in orthodontic treatment with fixed appliances. Moisture contamination of the enamel surface after etching and disturbances during the polymerization of the adhesive, variations in etching time and concentration are causes of low bond strength. Enamel surface contamination can occur at two critical stages of the bonding procedure which is after the tooth surface has been etched and after the primer has been applied. Following saliva contamination, the micro-porosities become plugged, and the penetration of the resin will be impaired, resulting in resin tags of insufficient number and length. Hence the bond strength gets compromised.[4,5,6] According to Reynolds, shear bond strength in the range of 5.9–7.8 MPa to resist masticatory force is clinically favorable and minimizes enamel fracture. Bond strength higher than 14 MPa can cause enamel cracks on the tooth surface during debonding.[7,8] Shear bond strength (SBS) depends on several factors, including the size and design of bracket base,

thickness and type of adhesive, bonding technique, type of bracket, and experience of the clinician.[9]
Light-cured and self-cured conventional composites for bracket bonding is lack of color contrast with the enamel, which may result in accumulation of resin remnants on the enamel surface after bracket debonding and polishing. Color-change light-cured composites were introduced to the orthodontic market to enhance differentiation of adhesive and enamel. Due to their different colors and contrasts, they can be easily detected on the tooth enamel during bonding and debonding procedures enabling their complete removal after bracket debonding.[10]
Thus, this in-vitro study is done to compare the shear bond strength of Transbond Plus with Grengloo and Blugloo when contaminated with saliva.

Materials: One hundred and twenty maxillary premolars extracted for orthodontic purpose or due to periodontal involvement with sound buccal surfaces were collected, cleaned thoroughly and stored in 0.1% (wt/vol) Thymol at room temperature for a period of two weeks. The light cure bonding adhesive used to bond the brackets for the study were Transbond Plus™ (3M Unitek, USA) ,Blugloo™ (Ormco corp. USA), Grengloo™ (Ormco corp. USA)(fig:1,3&2) .The primers used were Transbond XT light cure adhesive primer (fig:5)and Orthosolo(fig:4) from Ormco corp., USA. Orthodontic metal upper premolar brackets, 0.022 x 0.028 slot (Mini 2000 series, Ormco corp, USA) (fig:6) were used. The bracket base surface area was found to be 9.806 mm^2 as per information provided by the manufacturer. A commercially available artificial saliva (Wet mouth, ICPA Health products, Ankaleshwar, India) was used, which contains sodium carboxy methyl cellulose (1.0% w/vol), sorbitol (3% w/v), potassium chloride (0.12% w/v) and sodium chloride (0.12% w/v).

MATERIALS AND METHODOLOGY


Fig:1- Transbond Plus


Fig:2- Grengloo


Fig:3- Blugloo


Fig:4-Orthosolo


Fig:5-Transbond XT light cure adhesive primer

METHODOLOGY: The 120 teeth were divided into three groups consisting of 40 teeth each:

GROUP I - Transbond Plus(3M Unitek)
GROUP II - Grengloo (Ormco corp. USA)
GROUP III - Blugloo (Ormco corp. USA)

Each group was subdivided into four subgroups consisting of 10 teeth each:

A. No Contamination with Saliva
B. Contamination with Saliva before application of bonding agent
C. Contamination with Saliva after application of bonding agent
D. Contamination with Saliva both before and after application of bonding agent.

All teeth were mounted on the acrylic jig individually.

Method of mounting teeth:
A PVC sleeve of approximately 30mm length and 12 mm radius was taken. The inner portion was filled with acrylic and the teeth were aligned vertically in the centre of the PVC using a plumb line attached to a dental surveyor.

Color coding:
Acrylic jigs were color coded as follows:

TRANSBOND PLUS

SUB GROUP	COLOR CODE
Non contaminated	Silver
Contamination with saliva before bonding	Silver -red
Contamination with saliva after bonding	Silver -gold
Contamination with saliva before and after bonding	Silver- red- gold

GRENGLOO

SUB GROUP	COLOR CODE
Non contaminated	Green
Contamination with saliva before bonding	Green -red
Contamination with saliva after bonding	Green -gold
Contamination with saliva before and after bonding	Green - red- gold

BLUGLOO

SUB GROUP	COLOR CODE
Non contaminated	Blue
Contamination with saliva before bonding	Blue -red
Contamination with saliva after bonding	Blue -gold
Contamination with saliva before and after bonding	Blue - red- gold

Bonding protocol
The procedure of etching and priming of the teeth was carried out according to manufacturer's instruction. The teeth were bonded accordingly by the same operator and 40 each metal premolar brackets were bonded using Transbond Plus, Grengloo, Blugloo light cure adhesive respectively with a halogen light curing unit (3M Unitek, USA) which has a light intensity of 400 – 999 mW/cm^2 and a output wave length of 400–500 nm.

The first group was divided into four subgroups which were to be contaminated with artificial saliva in the order of above mentioned sub groups.

Fig 6-Orthodontic metal upper premolar brackets, 0.022 x 0.028 slot (Mini 2000 series, Ormco corp, USA)

Group I – Transbond Plus:
The first subgroup consisted of samples contaminated with saliva and the procedure was done according to the categories they were divided

Subgroup A: Consists of uncontaminated samples. After etching the enamel surface for 15 seconds with 37% phosphoric acid, the enamel was lightly dried and the Transbond Plus primer (3M Unitek) was applied for 3-5 seconds. An oil and moisture free air was used for 1-2 seconds to dry the primer into a thin film. Metal brackets (Mini 2000 brackets, Ormco corp, USA) were bonded to the centre of the buccal surface of the clinical crown and light cured for 40 seconds using halogen light curing unit.(fig:7a)

Subgroup B: Consists of samples contaminated with saliva before the primer application. The samples after enamel etching were contaminated with artificial saliva for 10 seconds with a brush and blown off with an air syringe for 5 seconds. The primer was then applied to the contaminated surface for 3-5 seconds and lightly air dried for 1-2 seconds. Metal brackets were bonded and light cured for 40 seconds as done previously.(fig:7b)

Subgroup C: Consists of samples contaminated with saliva after the primer application. The samples were etched and the primer was applied on the enamel for 3-5 seconds and lightly air dried for 1-2 seconds. The enamel was contaminated with artificial saliva for 10 seconds & blown off with an air syringe for 5 seconds. Metal brackets were bonded and light cured for 40 seconds as done earlier.(fig:7c)

Subgroup D: Consists of samples contaminated before and after primer application. After the acid etching procedure, the enamel was contaminated with saliva for 10 seconds and blown off with an air syringe for 5 seconds. The primer was applied on the contaminated surface for 3-5 seconds and lightly air dried for 5 seconds. The contamination procedure was repeated once again. Metal brackets were bonded and light cured for 40 seconds.(fig:7d)

Fig:7a

Fig:7b

Fig:7c

Fig:7d

Fig.7: Transbond Plus group divided into four subgroups and color coded as follows; (a) non contaminated, (b) contaminated with saliva before bonding, (c) contamination with saliva after bonding, (d) contamination with saliva before and after bonding.

The same procedure was done for the second group which was to be contaminated with saliva and also the respective procedures were continued where Orthosolo (Ormco Corp. USA) was used as primer and color changing adhesive Grengloo was used as adhesive in the place of Transbond Plus. The third group was contaminated with saliva and also the respective procedures were continued where Orthosolo (Ormco Corp. USA) was used as primer and color changing adhesive Blugloo was used as adhesive.

TESTING OF SHEAR BOND STRENGTH

Testing of the shear bond strength was conducted using a Universal Testing Machine at CENSE (Centre for Nano Science and Engineering), IISC, Bangalore at a room temperature of 25^0C (fig:8). The prepared acrylic blocks were placed on the metal jig and positioned on the Instron universal testing machine with the long axis parallel to the direction of the load application at a crosshead speed of 2mm/min. (fig:9)

Fig:8-Instron Universal Testing Machine

Fig:9- Acrylic jigs placed in Instron Universal testing Machine to test shear bond strength.

A progressive load was applied till the bracket was debonded from the tooth surface. The load at which the bracket debonded was recorded in Newton's and subsequently calculated in Mega Pascal's using the below mentioned formula:

$$\text{Bond strength in Mpa} = \frac{\text{Force in Newton}}{\text{Surface area of the bracket in mm}^2}$$

The bracket base area for metal brackets (Mini 2000, Ormco Corp, USA) is 9.806 mm^2 as per information provided by the manufacturer. The results obtained was subjected to statistical evaluation.

STATISTICAL ANALYSIS

One-way ANOVA test followed by Tukey's HSD post hoc Analysis was used to compare the mean shear bond strength between different study groups, in various conditions that is without saliva contamination, saliva contamination before etchant

application, contamination before bonding agent application & finally before adhesive application. Repeated measures of ANOVA followed by Bonferroni's post hoc analysis was used to compare the mean shear bond strength between various conditions in each study group.

RESULTS

Comparison of mean differences between groups under non contaminated condition revealed that mean shear bond strength for Transbond plus [8.82 ± 0.18] was significantly lesser as compared to Blugloo [9.94 ± 0.39] and Grengloo [9.67 ± 0.28], with p value of less than 0.001. However, no significant difference was noted between Blugloo and Grengloo [P=0.12].

Comparison of mean differences between contamination conditions for Transbond Plus group revealed that mean shear bond strength under non contaminated condition [8.82 ± 0.18] was significantly highest as compared to contamination before bonding [7.94 ± 0.48] at P<0.001, after bonding [8.24 ± 0.28] at P=0.007 and also contamination before and after bonding [7.68 ± 0.45] at P<0.001. Similarly, the mean shear bond strength for contamination after bonding was significantly higher as compared to the contamination before bonding with a p value of P=0.009. (fig:10)

However, no significant differences were noted in mean shear bond strength between contamination before bonding and after bonding [P=0.26] and also when compared with before and after bonding condition [P=0.44].

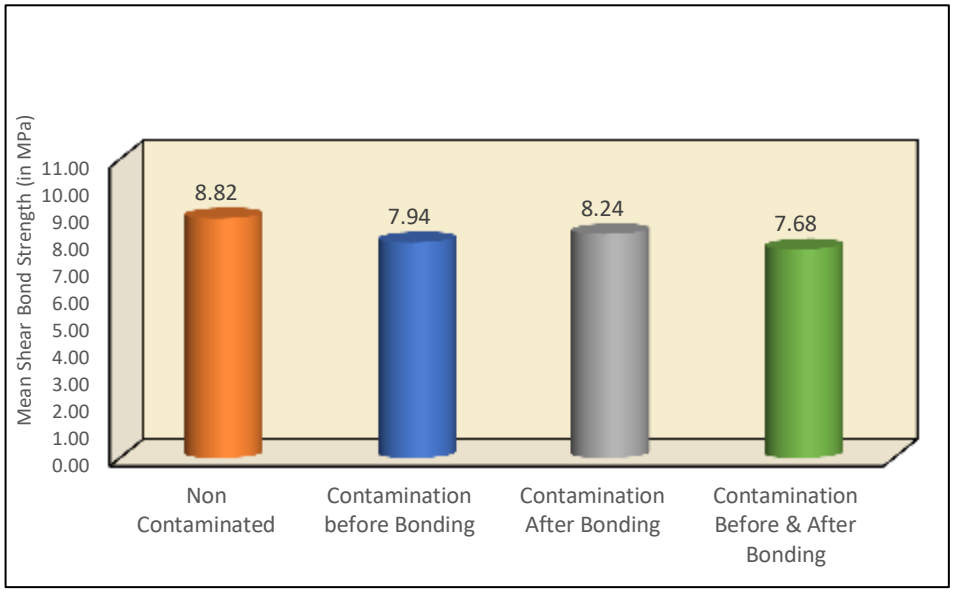

Fig:10- Mean shear bond strength (in Mpa) between different contamination conditions in Transbond Plus group

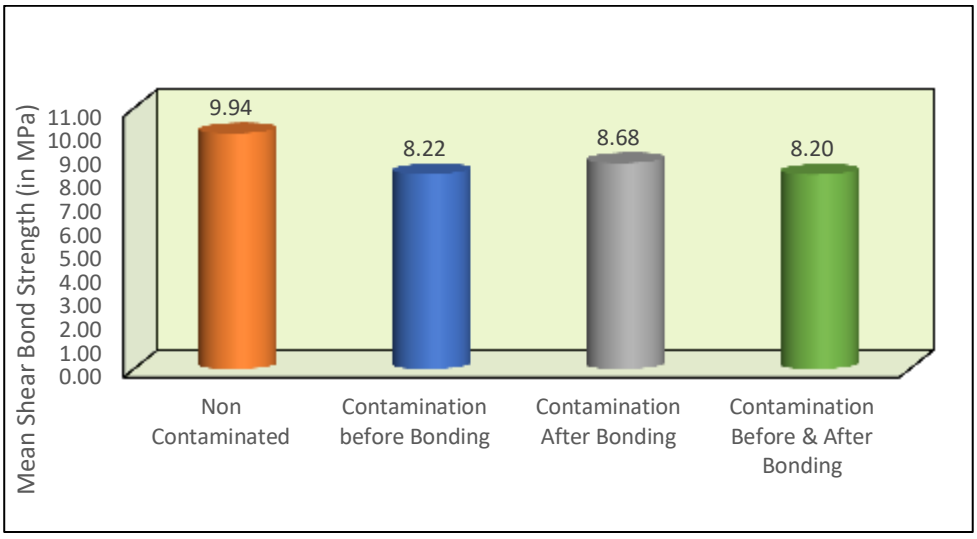

Fig:11- Mean shear bond strength (in Mpa) between different contamination conditions in Blugloo group

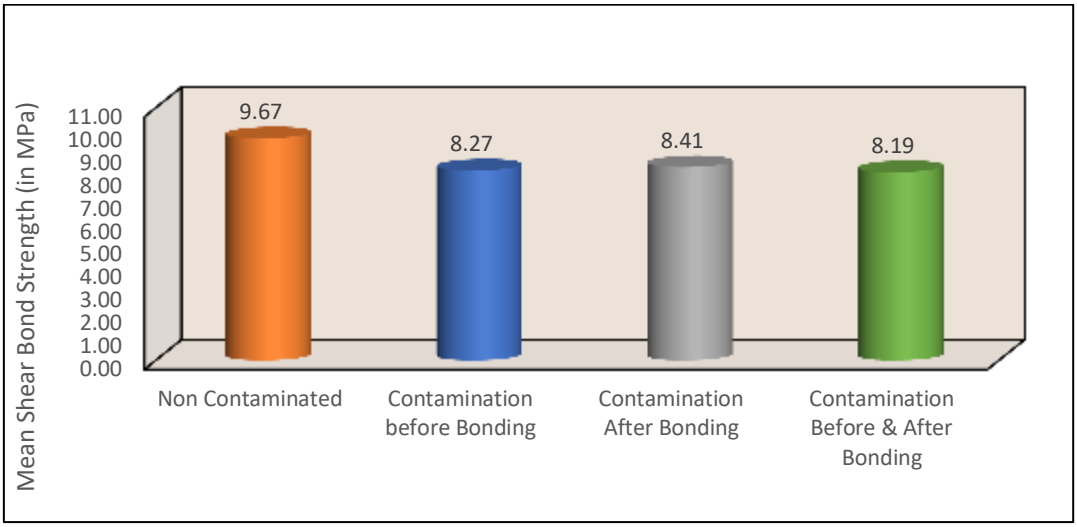

Fig:12- Mean shear bond strength (in Mpa) between different contamination conditions in Grengloo group

Comparison of mean differences between contaminated conditions for Blugloo group revealed that mean shear bond strength under non contaminated condition [9.94 ± 0.39] was significantly highest as compared to contamination before bonding [8.22 ± 0.48] at P<0.001, after bonding [8.68 ± 0.28] at P=0.001 .Similarly, the mean shear bond strength for contamination after bonding was significantly higher as compared to the contamination during bonding with p value equal to 0.003. (fig:11)

However, no significant differences were noted in mean shear bond strength between contamination before bonding and after bonding [P=0.03] and also when compared with before and after bonding condition [P=1.00].

Comparison of mean differences between contamination conditions for Grengloo group revealed that mean shear bond strength under non contaminated condition [9.67 ± 0.28] was significantly highest as compared to contamination before bonding [8.27 ± 0.31] at P<0.001, after bonding [8.41 ± 0.42] at P=0.001 and also contamination before and after bonding [8.19 ± 0.40] at P<0.001. (fig:12)

However, no significant differences were noted in mean shear bond strength between contamination before bonding and after bonding [P=0.79] and also when compared with before and after bonding condition [P=0.97].

DISCUSSION

The most common contaminants of enamel during bonding procedures are saliva and blood. While saliva is present in all bonding situations, blood becomes a problem if there is gingivitis or during surgical exposure of impacted teeth. Saliva consists mostly of water (99%), polysaccharides, proteins, and enzymes.[07,11] Saliva contamination forms a biofilm over the etched enamel reducing the surface energy. The micro-porosities get plugged, and the penetration of the resin will be impaired, resulting in resin tags of insufficient number and length thereby the bond strength gets compromised.[12,13,14] The negative effect of moisture on orthodontic bonding is due to water absorption and induction of a plasticizing effect in the polymer network by the formation of hydrated zones at the polar monomer sites, and oxidation of pendant C=C bonds attached to the network which release by-products such as formaldehyde thereby producing a plasticizing effect.[7] During debonding it can be difficult to delineate the enamel– adhesive interface, causing potential enamel loss and/or damage during its removal. Many studies have investigated the amount of enamel loss after debonding, with results in the range of 5–150 μm.[9,15]

Transbond ™ Plus is a color-change orthodontic bonding adhesive manufactured by 3M Unitek (Monrovia, CA) which claims excellent bond strength of the adhesive with both metal and ceramic brackets. The pink indicator incorporated in Transbond Plus becomes activated when it is exposed to light, both with ambient light and through curing.[16]

Blugloo™ is a dual color-change adhesive developed by Ormco Corporation (Glendora, CA) which claims an optimized formulation for esthetic brackets. At cooler temperatures the adhesive possesses a blue color, which then changes to a translucent color when the adhesive increases to warmer body temperatures.[17]

Grengloo™ (Ormco Corporation) is a similar dual color-change adhesive manufactured specifically for metal brackets. It polymerizes faster than other light-cured orthodontic bonding adhesives, providing a higher proportion of total bond strength at initial force loading. It is also designed to have up to 118%

greater impact resistance for reducing bond failures from traumatic impact.[17]

This is an in-vitro study done to compare the shear bond strength of Transbond Plus with Grengloo and Blugloo when contaminated with artificial saliva. Each adhesive group was subdivided into four sub groups namely no contamination, contamination with artificial saliva before application of bonding agent, contamination with artificial saliva after application of bonding agent and contamination with artificial saliva both before and after application of bonding agent. From the results and the observations of this study it is seen that Blugloo and Grengloo can be used in a situation where saliva contamination is expected to hinder the bonding procedures. Even though Transbond plus showed acceptable bond strength during saliva contamination procedures, it was less than that of both Blugloo and Grengloo. Comparison of the shear bond strength of Transbond Plus, Blugloo and Grengloo revealed that all had higher shear bond strengths than necessary for routine orthodontic treatment.

Similar results were reported in a study by Duers et al compared the bond strengths of different color-change adhesives (Transbond Plus, Blugloo, and Grengloo) relative to a conventional light cure adhesive (Transbond XT) used for orthodontic bonding. The study used 35% phosphoric acid etch and traditional primer to prepare the tooth surface prior to the addition of the adhesive and orthodontic bracket. Although the average shear bond strengths varied among the adhesives at two time points (15 minutes and 24 hours after bonding), all measurements were still within the recommended bond strength range for orthodontic bonding.

Vicente et al. (2005) found a significant increase in bond strength when brackets were bonded with Ortho Solo primer compared with Transbond XT primer or All-Bond 2 primer with Transbond XT adhesive.[06] On the contrary, Northrup et al. (2007) did not find a significant increase in bond strength when Ortho Solo was used, albeit with the Blugloo adhesive, compared with the other primer-adhesive combination of Transbond XT.[10]

Tais de morais et al (2010) evaluated the efficacy of Transbond Plus color change adhesive when used with Transbond self-etching primer under blood contamination. They found out that Transbond Plus when used with self-etching primer led to significantly higher shear bond strength than the conventional Transbond XT system.

Sara ekhlassi et al in the year 2011 compared the shear bond strength of color change adhesives for orthodontic bonding when used with self-etching primer. They found out that Transbond Plus had highest mean shear bond strength. Grengloo had the lowest mean shear bond strength.

From the results and the observations of this study we can say that both Grengloo and Blugloo can be used in a situation where saliva contamination is expected to hinder the bonding procedures. Even though Transbond Plus showed acceptable bond strength during saliva contamination procedures, it was less than that of Grengloo and Blugloo. The use of ortho solo might also have contributed to the increased bond strength in both Grengloo and Blugloo groups.

CONCLUSION

It was seen that Shear bond strength was the highest in the non-contaminated stage in both Blugloo and Grengloo (9.94 Mpa for Blugloo and 9.67Mpa for Grengloo) compared to Transbond plus (8.82 Mpa).Both Blugloo and Grengloo significantly showed higher bond strength values compared to Transbond plus while contaminated with artificial saliva. Hence, the use of either Blugloo or Grengloo is recommended in conditions where saliva contamination is expected. All three color changing adhesives can be used safely in orthodontic practice since they resulted in acceptable bond strengths. In situations where extra bond strength is needed, Grengloo and Blugloo may be preferred.

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