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COMPARISON OF SHEAR BOND STRENGTH OF TRANSBOND PLUS AND BLUGLOO ON CERAMIC SURFACE WHEN CONTAMINATED WITH SALIVA: AN IN- VITRO STUDY

Orthodontology

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ABSTRACT

AIM: The aim of the study is to compare and evaluate the shear bond strength of color changing adhesives Transbond Plus and Blugloo on ceramic surface under different conditions of saliva contamination.

METHODOLOGY: Ceramic blocks used in crown fabrication is used for the study. The blocks were divided into two groups; group I- transbond plus, group II-blugloo. Each group was subdivided into: A. No Contamination, B. Contamination with saliva. The procedure of etching and priming of the teeth was carried out according to manufacturer's instruction. Contamination of the mounted blocks 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=20), Blugloo (n=20). After 24 hours the brackets were tested for shear bond strength using a Universal Testing Machine. The results obtained were analysed with Independent Student t Test.

RESULT: The bonding performance of Transbond Plus and Blugloo was better in saliva uncontaminated condition. However, the bond strength of Blugloo was relatively higher than Transbond Plus. This may be due to the sealant, Ortho Solo, used in these groups.

CONCLUSION: Both the 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 Blugloo. In situations where extra bond strength is needed on a ceramic surface Blugloo may be preferred.

KEYWORDS

INTRODUCTION

There is an increase in the number of adult patients seeking orthodontic treatment.[1,2] This has encouraged orthodontists to test several different protocols with respect to bonding brackets to different dental restorations (specifically porcelain/ceramic restorations). Bonding orthodontic brackets to porcelain/ceramic surfaces presents a higher degree of failure when compared to bonding to enamel. Many times this is attributed to the porcelain type and surface conditioning, bracket material (base design, retention mode), properties of the bonding adhesive and the light-curing source, as well as the skill of the clinician.[2,3] Also, adequate bond strength is desired with easy removal to avoid damage of the restored teeth.[4,5] Several techniques have been used to bond brackets to porcelain surfaces and these differ in surface preparation and bonding agent applied. Some examples of these have been reported with the use of phosphoric acid [6] or hydrofluoric acid.[7] Other studies tested the use of silane coupling agents [8].

Bond failures due to moisture contamination are common implications in orthodontic treatment with fixed appliances. Moisture contamination of the bonding surface after etching and disturbances during the polymerization of the adhesive, variations in etching time and concentration are causes of low bond strength.[9]

Light-cured and self-cured conventional composites for bracket bonding have 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]

Although many articles are published on the effect of saliva and blood contamination on shear bond strength comparing moisture tolerant adhesives, no study has been conducted to compare the efficiency of colour changing adhesives when contaminated with saliva on ceramic surface. Hence this in-vitro study is done to compare the shear bond strength of Transbond Plus with Blugloo on ceramic surface when contaminated with saliva

MATERIALS AND METHODOLOGY

Materials: Ceramic blocks (Dentgallop™, USA) used for crown fabrication is used for the study. (fig:1) The light cure bonding adhesive used to bond the brackets for the study were Transbond Plus™ (3M Unitek, USA) and Blugloo™ (Ormco corp. USA).(fig:2&3) The primers used were Transbond XT light cure adhesive primer (fig:4)and Orthosolo(fig:5) from Ormco corp., USA. The etchant used was 9% hydrofluoric acid (Ultradent Porcelain etch refill™). 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).

Fig:1: Ceramic Block

fig:2: Transbond Plus

fig.3: Blugloo

Fig.4: Transbond XT

Fig.5: Orthosolo

METHODOLOGY:

The blocks were divided into the following groups:
GROUP I - Colour changing adhesive [Transbond Plus]
GROUP II - Colour changing adhesive [Blugloo]

Each group will again be subdivided into:
A. No Contamination
B. Contamination with Saliva

Bonding Protocol

All four subgroups were assigned with one ceramic block each. 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 20 each metal premolar brackets were bonded using Transbond Plus and 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 an output wave length of 400–500 nm.

Each group were subdivided into two subgroups. Artificial saliva contamination in 'contamination with saliva' sub groups was done after rinsing of etchant and is then followed by application of bonding agent.

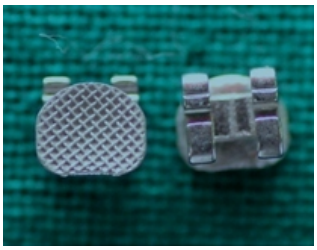


Fig:6-Orthodontic metal upper premolar brackets, 0.022 x 0.028 slot (Mini 2000 series, Ormco corp, USA)

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^{0}C (fig:7). The prepared acrylic blocks were placed on the metal jig and positioned on the Universal testing machine with the long axis parallel to the direction of the load application at a crosshead speed of 2mm/min. (fig:8)

Fig:7-Instron Universal Testing Machine

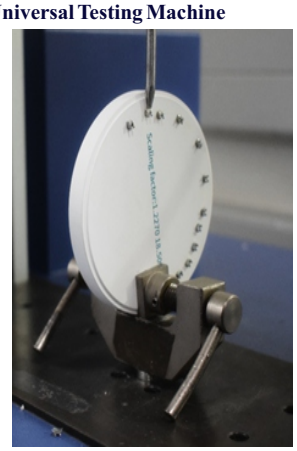


Fig:8- ceramic block with brackets bonded placed in Instron Universal testing Machine to test shear bond strength

A progressive load was applied till the bracket was debonded from the ceramic 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 mm2 as per information provided by the manufacturer. The results obtained was subjected to statistical evaluation.

STATISTICAL ANALYSIS

Independent Student t Test was used to compare the mean shear bond strength (in Mpa) between Transbond Plus and Blugloo groups under with and without saliva contamination conditions.

RESULTS

Table no. 1 Comparison of Mean Shear Bond Strength (in MPa) between Transbond Plus and Blugloo groups without Saliva Contamination using Independent Student t Test

Groups	N	Mean	SD	Mean Diff	95% CI of Mean Diff		t	P-Value
					Lower	Upper		
Transbond Plus	10	8.12	0.57	-2.52	-2.97	-2.06	-11.636	<0.001*
Blugloo	10	10.64	0.38					

Comparison of the mean Shear Bond Strength (in mpa) between Transbond Plus and Blugloo groups without Saliva Contamination was done using Independent Student t Test. The test results demonstrated that, the Blugloo group [10.64 ± 0.38] showed significantly higher mean shear bond strength as compared to Transbond Plus group [8.12 ± 0.57]. This mean difference of -2.52 mpa [95% CI, -2.97 to -2.06] in the mean shear bond strength between 2 groups without saliva contamination was statistically significant at P<0.001.

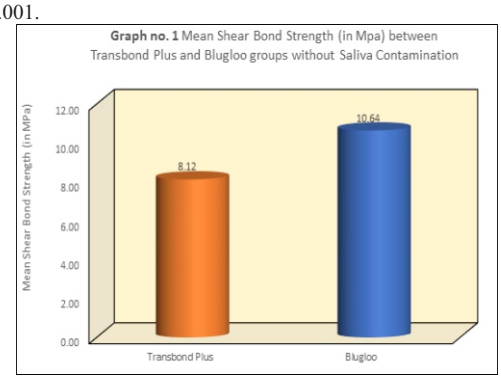


Table no. 2 Comparison of Mean Shear Bond Strength (in Mpa) between Transbond Plus and Blugloo groups with Saliva Contamination using Independent Student t Test

Groups	N	Mean	SD	Mean Diff	95% CI of Mean Diff		t	P-Value
					Lower	Upper		
Transbond Plus	10	7.15	0.42	-0.87	-1.20	-0.53	-5.437	<0.001*
Blugloo	10	8.02	0.28					

Comparison of the mean Shear Bond Strength (in MPa) between Transbond Plus and Blugloo groups with Saliva Contamination was done using Independent Student t Test. The test results demonstrated that, the Blugloo group [8.02 ± 0.28] showed significantly higher mean shear bond strength as compared to Transbond Plus group [7.15 ± 0.42]. This mean difference of -0.87 MPa [95% CI, -1.20 to -0.53] in the mean shear bond strength between 2 groups with saliva contamination was statistically significant at P<0.001.

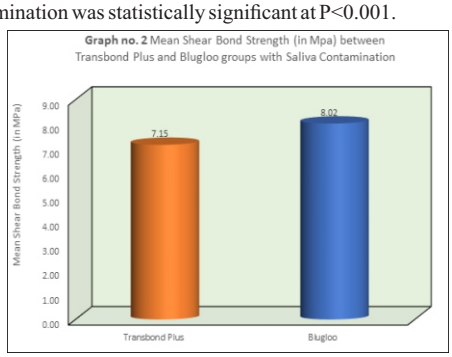


Table no. 3 Comparison of Mean Shear Bond Strength (in Mpa) between With and Without Saliva Contamination among Transbond Plus groups using Independent Student t Test

Groups	N	Mean	SD	Mean Diff	95% CI of Mean Diff		t	P-Value
					Lower	Upper		
No Contamination	10	8.12	0.57	0.97	0.50	1.44	4.358	<0.001*
Contamination with Saliva	10	7.15	0.42					

Comparison of the mean Shear Bond Strength (in Mpa) between with & without Saliva Contamination among Transbond Plus groups was done using Independent Student t Test. The test results demonstrated that the No Contamination group [8.12 ± 0.57] showed significantly higher mean shear bond strength as compared to the group contaminated with saliva [7.15 ± 0.42]. This mean difference of 0.97 MPa [95% CI, 0.50 - 1.44] in the mean shear bond strength between 2 groups of with & without saliva contamination among Transbond Plus groups was statistically significant at P<0.001.

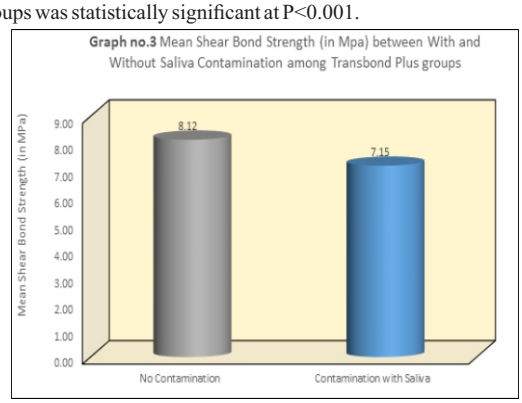
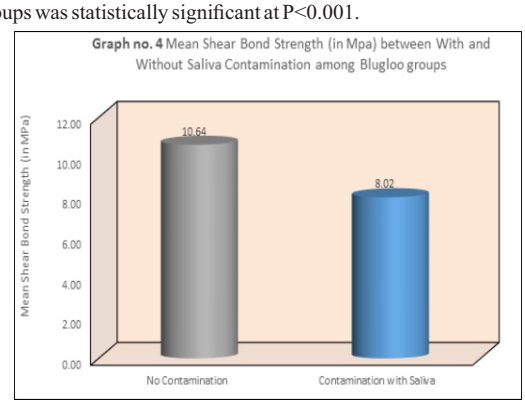


Table no. 4 Comparison of Mean Shear Bond Strength (in Mpa) between With and Without Saliva Contamination among Blugloo groups using Independent Student t Test

Groups	N	Mean	SD	Mean Diff	95% CI of Mean Diff		t	P-Value
					Lower	Upper		
No Contamination	10	10.64	0.38	2.62	2.30	2.93	17.352	<0.001*
Contamination with Saliva	10	8.02	0.28					

Comparison of the mean Shear Bond Strength (in Mpa) between with and without Saliva Contamination among Blugloo groups was done using Independent Student t Test. The test results demonstrated that, the No Contamination group [10.64 ± 0.38] showed significantly higher mean shear bond strength as compared to the group contaminated with saliva [8.02 ± 0.28]. This mean difference of 2.62 MPa [95% CI, 2.30 to 2.93] in the mean shear bond strength between 2 groups of with and without saliva contamination among Blugloo groups was statistically significant at P<0.001.



DISCUSSION

Saliva and blood are the most common contaminants of enamel during bonding procedures. While saliva is present in all bonding situations, blood contamination is present in patients with gingivitis or during surgical exposure of impacted teeth. Saliva consists mostly of water (99%), polysaccharides, proteins, and enzymes.[11,12] 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.[11]

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.[13]

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.[14]

In the study performed by Trakyali et al[16] the optimum concentration of hydrofluoric acid was investigated in vitro. They found higher SBS in the 9.6% hydrofluoric acid etching group, but there was no statistically significant difference between the 9.6% and 5% hydrofluoric acid concentrations.[16] In the current study, 9.6% hydrofluoric acid was applied as a chemical etching agent to etch the surface of ceramic, which is frequently used in dentistry.

Throughout different studies, it is apparent that the use of hydrofluoric acid greatly increases the bond strength. This is due to the acid's ability to react with the silica phase, which creates micromechanical retention through microchannels. Over time, the glassy matrix partially dissolves and increases the formation of retentive channels. The etching of HFA ultimately increases the surface area, which helps penetrate the resin cement into the microchannels created. The longer etching time increases the bond strength as it allows the acid to react with the ceramic matrix and partially dissolve it. The studies that tested different acid concentrations concluded that the use of a strong acid to etch porcelain increases the bond strength because the acid creates a series of pits on the surface by dissolution of the glass phase from the ceramic matrix.[15]

Andreasen and Stieg[17] found that fracture of the porcelain itself was experienced during both tensile and shear testing when the silane coupling agents were used to increase the bond strength of orthodontic adhesives.[17]

This is an in-vitro study done to compare the shear bond strength of Transbond Plus with Blugloo on ceramic surface when contaminated with artificial saliva. Each adhesive group was subdivided into two sub groups namely no contamination and contamination with artificial saliva. From the results and the observations of this study it is seen that Blugloo can be used on ceramic surfaces 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 on ceramic surfaces. Comparison of the shear bond strength of Transbond Plus and Blugloo revealed that both had higher shear bond strengths than necessary for routine orthodontic treatment. The use of ortho solo might also have contributed to the increased bond strength in Blugloo group.

Shear bonding tests involve numerous variables and are technique-sensitive, so the same bonding study can have varying results under different experimental conditions or when performed by different operators. An in vitro bonding environment is very different from an in vivo bonding environment. Factors such as saliva contamination and the patient's enamel composition can cause the same bonding study to yield different results when performed intraorally. Thus, it is important to follow through with more clinical studies. It may be of interest to test the color-change adhesives further by bonding them directly to the ceramic surface (without a metal bracket). In this way, bond strength at the enamel–adhesive interface can be evaluated without the added variable of the bracket– adhesive interface. Further studies have to be conducted on these materials under different conditions to analyze their efficiency.

CONCLUSION

It was seen that the Blugloo group [10.64 ± 0.38] showed significantly higher mean Shear bond strength as compared to Transbond Plus group [8.12 ± 0.57] under non contaminated conditions. Both groups exhibited higher mean shear bond strengths in non-contaminated conditions when compared to saliva contaminated conditions. The Blugloo group [8.02 ± 0.28] showed significantly higher mean Shear bond strength as compared to Transbond Plus group [7.15 ± 0.42] under saliva contaminated conditions. Hence Blugloo can be preferred over transbond plus on ceramic surfaces in both non contaminated and saliva contaminated conditions when extra bond strength is required.

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