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COMPARATIVE EVALUATION OF EFFECTIVENESS AND EFFICIENCY OF TWO COLOR CHANGING BRACKET BONDING ADHESIVES- A PROSPECTIVE CLINICAL STUDY

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ABSTRACT

Introduction: The aim of the study was to evaluate and compare the clinical performance of two color changing bracket bonding adhesives (Transbond Plus and Grengloo), in terms of bond failure rate, bonding time and time taken by the adhesives to change color. **Methods:** Eight consecutive patients seeking orthodontic fixed appliance therapy were bonded using Cross arch Split mouth technique, which involves the placement of two varieties of bracket bonding adhesives in diagonally opposite quadrants and cured using a visible light curing unit. The time taken by the adhesive to change color during bonding and the bonding time was noted using a stop watch. The bond failure rates of both the adhesives were evaluated by a thorough follow up of individual case, as and when they reported to the department with a debonded bracket. The data collected were subjected to statistical analysis using Chi square test and student's t-test. **Results:** The overall bond failure rate for two color changing adhesives were 7.1 % and 8.6 %,bonding time was 59.1 and 57.4 seconds per tooth and time to change color was 45.9 and 46 seconds. **Interpretation & Conclusion:** There were no significant differences between the failure rates, bonding time and time taken by both the adhesives to change color showing that both are clinically efficient and effective. Clinically they are preferred over the non color changing bracket bonding adhesives as these materials save clinical chairside time because of their color changing property which helps in easy flash removal while bonding brackets.

KEYWORDS :- Bonding,colour change,light cure,transbond plus,Grengloo,3m unitek,ormco.

INTRODUCTION

Bonding of orthodontic attachments to enamel has been in use for over 40 years, although the exact date of the first use of the technique is disputed.[1,2,3] The success of the fixed appliance therapy depends on attachments having adequate bond strengths and a low failure rate. The overall time required to place an appliance is an important factor in the cost of the treatment, whilst the need to replace the brackets frequently may severely impair the progress of fixed appliance therapy, and can be costly in terms of materials and time. Orthodontic attachments are subjected to a large number of forces in mouth, resulting in a complex distribution of stresses within the adhesive and its junctions with the enamel and the bracket base. Bond strength to enamel will depend on a large number of factors including the nature of the enamel surface, enamel conditioning and procedures, the types of adhesive used, and the shape and design of the bracket base.

A clinical study by Zachrison reported that carefully performed bonding technique may be of value, particularly on anterior teeth, premolars and mandibular second molars, while the evidence at hand would suggest that first molars are better banded.[4] Another study supported the previous study by showing that lowest failure rates were found with banding on buccal teeth and bonding on anterior teeth. Access, high occlusal forces and moisture contamination was found to be the reasons why author suggested banding the molars.[5]

A comparative study showed that bracket placement and flash removal were found to be much easier with the light-activated composite than with the autopolymerising system.[6] Whereas a longitudinal study done to evaluate and compare the rate of success or failure between a visible light cured bonding material and chemically cured bonding material did not reveal any statistically significant differences between the failure rates of the two systems.[7]

With advances in dental materials and techniques, bonding of orthodontic brackets is easier and more predictable, but recent advances make bonding more efficient and effective.

Fig.1: TRANSBOND PLUS – color changing Adhesive

Fig.2: - GRENGLOO ADHESIVE

Fig.3:- Armentarium

Figure No.4: - TRANSBOND-Flash removal

Fig.5. GRENGLOO- Flash removal

Recently two color changing bracket bonding adhesives namely Transbond Plus color changing adhesive (3M) and Grengloo (Ormco) have been introduced which provided enhanced time for bracket position and easy flash clean up as compared to conventional bonding adhesives[8,9]. These innovative products have the promise of increasing the efficiency of bonding process; however, their superiority over each other in terms of bracket failure and working time has not been evaluated.

Hence, this study is aimed at evaluating the effectiveness and efficiency of two color changing bracket bonding adhesives by comparing their clinical failure rate, bonding time and time taken by each material to change color. Null hypothesis for this study is that there is no difference in the effectiveness and efficiency between two color changing bracket bonding adhesives.

Materials and Methods

Materials

The subjects of this study were patients seeking treatment at the Department of Orthodontics, College of Dental Sciences, Davanagere. Following ethical approval, 8 consecutive patients (6 females and 2 males, age range: 12–22 years) who required orthodontic therapy by means of fixed appliances, were selected and treated by the author **(Table-I).**

Table 1. Sample characterstics

1.	Number of Patients		8
2.	Mean age		16.5 Years
3.	AgeRange		12 – 22 Years
4.	Gender	Male	02
		Female	06
5.	Number of quadrants bonded		32
6.	Quadrants bonded with 3M		16
7.	Quadrants bonded with ORMCO		16

The adhesives were randomly allocated using the split-mouth design. Informed verbal consent of the patients was a prerequisite for enrollment. The mouth of each patient was divided into quadrants and the contralateral bonding pattern was randomly alternated from patient to patient in order to assure an equal distribution of adhesives between the right and the left side of the dental arches. All teeth, except the molars, were directly bonded. The selection criterion was the absence of occlusal interferences on any of the bonded brackets, chosen in an effort to eliminate the influence of trauma on failure rate. Enamel surfaces presenting caries, fillings, or gingival hyperplasia were likewise excluded from the study.

Total 140 brackets were bonded out of which 70 brackets were bonded using Transbond Plus color changing adhesive **(Fig. 1)** and rest 70 brackets were bonded using Grengloo **(Fig. 2).** Unitek™ Gemini metal brackets with MBT™ prescription (3M Unitek) were used in the present study. Curing was done using a Halogen light curing unit (3M ESPE curing light 2500).Stop watch was used to check the time **(Fig. 3).**

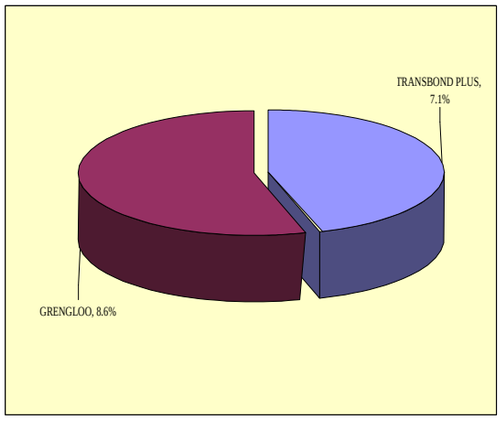
Methods

A standardized protocol of tooth preparation and bracket bonding was adopted for all the patients. After fitting and cementing molar bands onto the first and second permanent molars, all teeth were isolated and cleansed with a mixture of water and pumice using a rubber-polishing cup on a low speed hand piece. The teeth were rinsed and dried with an oil-free air syringe, and were etched quadrant wise with the conventional acid etching technique[10] (37 per cent orthophosphoric acid applied for 30 seconds). They were subsequently rinsed thoroughly with water to ensure total removal of etchant and dried according to the manufacturer's instructions. A liberal coat of primer (Ortho SOLO Universal bond enhancer, Ormco, for Grengloo adhesive and Transbond XT Light cure adhesive for Transbond Plus color change adhesive) was applied to etched area of teeth using a nylon brush. Air was gently blown on each tooth for 2–5 seconds, aiming the air stream perpendicular to the enamel surface. Adhesive was applied to bracket base. The bracket was then positioned to the enamel surface and adjusted to final position by exerting a pressure to firmly seat it. Excess adhesive surrounding the bracket (Flash) was gently removed **(Fig 4 and Fig. 5)**. Light curing was done for 20 seconds. Bonding time was noted quadrant wise from the moment adhesive was placed on the bracket base till all the teeth were cured. Bonding time for individual tooth were found by adding the time taken to bond each quadrant using a particular adhesive and dividing it by the total number of teeth bonded using that adhesive. Time to change color was noted individually for each tooth from the moment adhesive was placed on the bracket base till the adhesive becomes colorless. The patients were followed for a period of 3 months. Bond failures were recorded in each patient's special record, with the time of bond failure identified as the date when bond failure was noticed.

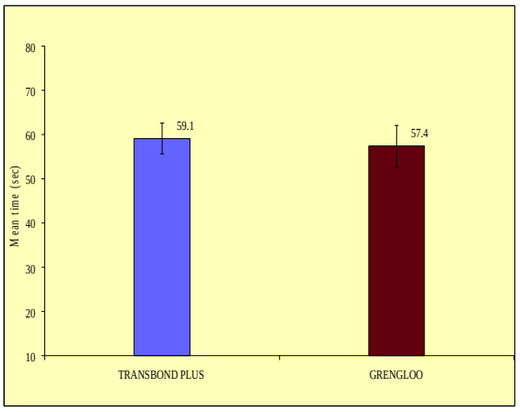
All patients received the same instructions and were seen at 3-4 week intervals. They were, however, requested to attend as soon as possible once a bond failure was apparent. They were instructed to brush using a fluoride-containing toothpaste.

Statistical Analysis

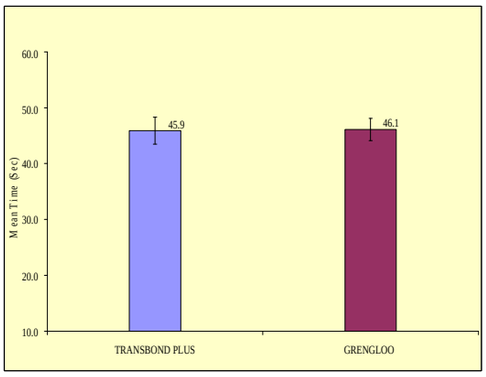
Statistical comparison of bond failure rates during a period of 3 months were for each color changing adhesive was done using Chi square test. Bonding time and time taken to change color were compared using unpaired student's-t test. A p-value of 0.05 or less was considered significant.



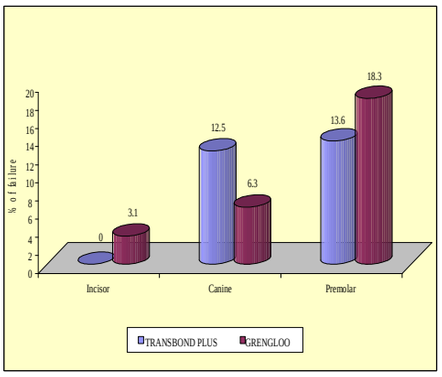
Graph 1:Total failure rate of brackets bonded with TRANSBOND PLUS and GRENGLOO adhesives



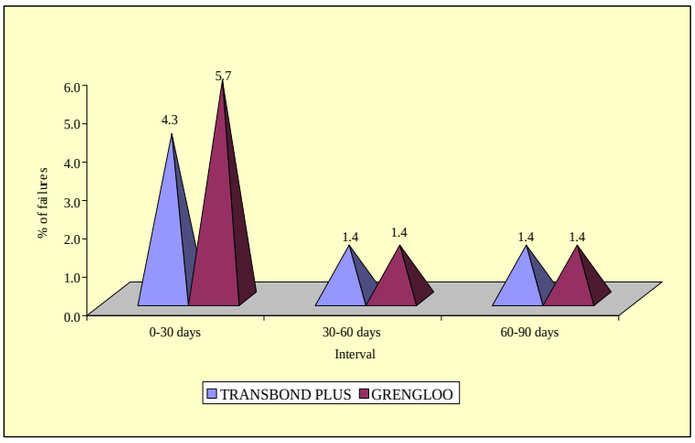
Graph 2:Time taken to bond using different adhesives



Graph 3: - Time taken for complete colour change



Graph 4: - Bond failure rate accord-ing to site of fracture



Graph 5: - Bond failure rate in relation to the interval following bonding

Student t-test (Unpaired): $t = \frac{\text{Difference in the means}}{\text{Standard error of difference}}$

Results

Bracket failure rate

A total of 11 bond failures were registered during the 3 months of the observation period: 5 (7.1%) occurred with Transbond Plus color changing adhesive while 6 (8.6%) with Grengloo (Table-II). Chi square test revealed that there was no significant difference between the bracket failure rate of two adhesives (P>0.05). **(Graph-1)**

Bonding time

Average time taken to bond individual tooth using Transbond Plus was 59.1 seconds whereas for Grengloo it was 57.4 seconds (Table-III). Students 't' test revealed that there was no significant difference in bonding time using the two adhesives (P>0.05). **(Graph-2)**

Time to change color

Time taken by Transbond Plus color changing adhesive to undergo complete color change was 45.9 seconds and for Grengloo it was 46.1 seconds.**(Table-IV).** No significant difference was found for the time taken to undergo color change between the two adhesives (P>0.05). **(Graph-3)** .Irrespective of the adhesive used, data analysis **(Table-V) (Graph-4)** revealed that mandibular left posterior teeth were having more bond failures and maximum failure occurred within the first 30 days of bonding**. (Table-VI) (Graph-5)**

Null hypothesis of the study was accepted. In fact, the present investigation demonstrated that there is no difference in the effectiveness and efficiency of two color changing bracket bonding adhesives.

Discussion.

Study Design

Invitro investigation of bond strength plays an important role in evaluating the bonding efficiency of newly introduced orthodontic systems. While it is true that certain aspects of physical and chemical adhesive properties may be clarified by ex vivo approaches, the actual performance of the system can only be evaluated in the environment where it was intended to function[11]. Therefore, the most reliable method to illustrate the clinical efficiency of new bonding materials is the evaluation of clinical bond failure rate using randomized controlled clinical trail methodology. A clinical trail is a planned experiment on human beings which is designed to evaluate the effectiveness of one or more forms of treatment.[12]

In this study a 'Split-mouth' design was used where one side or contralateral quadrants were bonded using Transbond plus adhesive, whilst the alternative side was bonded with Grengloo adhesive. The advantage of this is that 'patient factor', such as poor care of the appliances will be accounted for evenly, as the patient acts as their own control.

All patients were bonded by one clinician to eliminate inter-examiner variation. Only first time bond failures were recorded. This was to eliminate possible variation in bond strength introduced from rebonding which may have skewed the results. Kinch[19] found a less favourable survival rate of second and third time bonds compared to first time failures. It is therefore recommended that clinical studies evaluating bond failure rates should either only record first time failures or analyze multiple failures of the same site in a differential category.[13]

Bond Failure rate

According to Hitmi[14], failure rates are a widely accepted means of assessing bracket performance which allows effective comparison with the results in the literature. In this in-vivo study the bond failure rate of Transbond-Plus was 7.1 percent and Greenglow was 8.6%. Bond failures rates below 10 percent are generally considered as clinically acceptable[15], although the direct comparison between studies should be interpreted with caution, since there is not yet a standardized protocol for such clinical studies.[16,17] Although there was no significant difference (p>0.05) between the bracket failure rates of two color changing adhesives, both adhesives showed less percentage of bracket failure compared to failure rates of conventional adhesives in previous studies.[4] This confirms that both color changing adhesives produced adequate bond strengths and appear to perform well clinically. None of them could therefore be considered as clinically inferior in terms of bond failure. In in-vivo studies, socio-economic and the dental status of patient, malocclusion classification, and resultant mechanotherapy may affect the outcomes. Furthermore, masticatory forces varying the facial type, culturally influenced dietary habits, and gender differences may also influence the results.[4] It was also noted that mandibular left posterior teeth were having more bond failures and maximum failures occurred in the first 30 days of bonding.

The higher failure rate on mandibular teeth than on maxillary teeth is similar to findings reported in previous studies.[5,18,19,20,21,22] An explanation for this difference could be higher risk for moisture contamination of the mandibular teeth and the occlusal forces exceeding the bond strength of the brackets to teeth. Indeed, according to Reynolds[23] the major forces that appliances must be able to withstand during orthodontic treatment are occlusal. All this is in contradiction to the results of Carstersen's study[24], where the bond failure rate was

Table.2: Total failure rate of brackets bonded with TRANSBOND PLUS and GRENGLOO adhesives				
Adhesives	No. of quadrants	Brackets Bonded	No. of Failures	Percentage of Failure
Transbond Plus	16	70	5	7.1%
Grengloo	16	70	6	8.6%
Chi-square test; $x^2 = 0.10$; p=0.75, ns				

Table.3-Time taken to bond using different adhesives						
Adhesives	Mean bonding time		S.D.		t*	p
	Per quadrant (Minutes)	Per tooth (Seconds)	Per quadrant (Minutes)	Per tooth (Seconds)		
TRANSBOND PLUS	15.7 (14-17)	59.1	0.93	3.5	1.16	0.26, ns (p>0.05)
GRENGLOO	15.31 (14-17)	57.4	1.25	4.7		
Unpaired t-test.						

Table.4.Time taken by the adhesive to change colour completely				
Adhesives	Mean decolourization time	S.D.	t*	P
Transbond Plus	45.9	2.4	0.66	0.51, NS
Grengloo	46.1	2.0		
Unpaired t-test.				

Table.5. Bond failure rates according to site of failure

Site of Bond Failure		Brackets Bonded	Number Failed	Percentage Failed
Arch	Upper arch	70	2	2.85
	Lower arch	70	9	12.85
Side	Right Side	70	2	2.85
	Left side	70	9	12.85
Teeth	Incisor	64	1	1.56
	Canine	32	3	9.36
	Premolar	44	7	15.9

Table-6: -Bond failure rate in relation to the interval following bonding.

Time following bonding (days)	No. of brackets failed		Percentage failure	
	Transbond Plus	Grengloo	Transbond Plus	Grengloo
0 – 30 days	3	4	4.3%	5.7%
30 – 60 days	1	1	1.4%	1.4%
60 – 90 days	1	1	1.4%	1.4%
Total	5	6	7.1%	8.6%

higher in the maxilla than in the mandible. Some studies found no difference in bond failure rate between maxillary and mandibular arch.[13,15,16,25,26,27]

Comparison of failure rates between anterior and posterior teeth showed premolar teeth suffer more bracket failures than incisors and canines.[28,29] Results obtained were comparable with previous studies[19,30,31,32]. The reasons for this phenomenon may be found in the difficulty in maintaining dryness in this area, poor visibility, heavy occlusal forces[13,33] and access problems for clinical procedures posteriorly.[7,18,32,34] Furthermore, the brackets of these teeth may have been manipulated for accurate placement.[35] In addition, Lovius and Associates[20] have suggested that the micromechanical bond properties of premolars could be adversely affected because of a larger amount of prismatic enamel on these teeth.[36] However, in two recent clinical studies no statistically significant difference was found between six anterior and four posterior teeth (First and second premolar).[37,38]

It was also noted that more brackets failed in the left side of the mouth than on the right. This was surprising as great care was taken to follow the standardized bonding procedure. Ghasseni[39] reported that bracket base fit at the tooth surface played a very important role in determining bond strength. This factor does not seem to have been important in the present study; the brackets must all have fitted equally well or equally badly. The fact that the operator was right handed may have resulted in better access, bracket placement and easier moisture control on the right side.[15] The habitual side during mastication and the difference in pressure assess during tooth brushing[29] could also have added to less failure on right side.

Bonding Time

The mean bonding time per tooth using Tansbond plus was 59.1 seconds and using Grengloo, it was 57.4 seconds. Though there was no significant difference between both ($p>0.05$), they showed significantly lower bonding time compared to conventional adhesives tested in previous studies[30]. This shorter bonding time translates into reduced clinical chair time, which increases cost – effectiveness.[22,40,41] In addition, reduced time may increase the patients comfort.

Time to Change Color

Time taken by the adhesives to undergo color change was noted from the moment adhesive is placed behind the bracket till the adhesive undergoes complete color change. Both the adhesives did not undergo color change until the beginning of light curing. Since none of the adhesive changed color before light curing it was concluded that both the adhesives gave adequate working time for better placement than other light cure adhesives under ambient light conditions, affording you more flexibility to place and position brackets, remove flash and begin light curing. Both manufacturers say that color change does not indicate complete polymerization of adhesive. Under ambient light, color fades away several minutes before the adhesive cures.

Transbond plus color change adhesive appears pink in color initially and color fades away after light curing. It also has additional properties of moisture tolerance, fluoride release and it can be used with metal and ceramic brackets (3M). Whereas Grengloo is a two way color change adhesive. As it is warmed to body temperature, the color disappears, remaining clean throughout treatment. When debonding, by simply introducing a short blast of cool air or water (which will lower the bonding surface temperatures) Grengloo will turn to green color again for easy and thorough clean up (Ormco). It is also having the properties of quick-cure polymerization which provides greater shear bond strength at initial force loading, great impact resistance and superb handling characteristics.

CONCLUSION

The results of this study suggest that there is no significant difference in bracket failure rate, bonding time and time taken to undergo color change among the two color changing adhesives. Both adhesives appear to perform equally well and the decision to use a particular adhesive will come down to individual clinical preference. For example orthodontists who requires moisture tolerance property could choose Transbond plus and orthodontist who would require the property of color to come back after debonding for easy removal of remnant adhesive on tooth could choose Greengloo. Additional factors like the cost will further influence adhesive choice.

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