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ORIGINAL PAPER

Effect of Dental Chair Light on Enamel Bonding of Orthodontic Brackets Using Light Cure Based Adhesive System: An In-Vitro Study

Anil Tiwari, Tarulatha Shyagali, Sarvraj Kohli, Rishi Joshi, Abhishek Gupta, and Rana Tiwari

[1]Department of Orthodontics and Dentofacial Orthopedics, Hitkarini Dental College and Hospital, Jabalpur, MP, India

Corresponding author: Dr.Tarulatha R Shyagali, Professor and Head, Department of orthodontics and dentofacial orthopedics, Hitkarini Dental College and Hospital, Jabalpur, MP, India Mobile: 07742129768. E-mail: drtarulatha@gmail.com

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ABSTRACT

Aim: The aim of this in vitro study was to evaluate the influence of the Dental chair light on the bond strength of light cured composite resin. **Materials and Methods:** Sixty therapeutically extracted human premolar teeth were randomly allocated to two groups of 30 specimens each. In both groups light cured composite resin (Transbond XT) and MBT premolar metal brackets (3M Unitek) was used to bond brackets. In group I and II light curing was done using Light-emitting diode light curing units without and with the dental chair light respectively. After bonding, all samples were stored in distilled water at room temperature for 24 hours and subsequently tested for shear bond strength and Adhesive Remnant Index (ARI) scores. Data was subjected to Mann Whitney U statistical test. **Results:** Results indicated that there was significantly higher shear bond strength (7.71 ± 1.90) for the Group II (composite cured with LED and dental chair light) compared with Group I (composite cured with LED LCU only) (5.74 ± 1.13).the obtained difference was statistically significant. There was no statistical significant difference between ARI scores in between the groups. **Conclusions:** light cure bonding with dental chair light switched on will produce greater bond strength than the conventional bonding. However, the ARI score were similar to both the groups. It is advised that the inexperienced orthodontist should always switch off the dental chair light while bonding for enough working time during the bracket placement.

Key words: composite resin; shear bond strength, dental chair light, ARI score.

1. INTRODUCTION

Introduction of light curing adhesive is a boon to orthodontist and for the efficient orthodontic treatment requires adequate bracket bonding. As more patients are interested in getting done the orthodontics, the need of the hour is clinical efficiency (1). The inefficient bracket bonding can increase the chances of appliance breakage, which results in prolonged treatment duration, increased chair side time and the greater inconvenience to the orthodontist and the patient.

The initiation of polymerization was done using the visible light in the blue area range of the electromagnetic spectrum to excite the outermost layer of the camphoroquinone that possesses an absorption spectrum in the interval between 400 and 500 nm. The most efficient wavelength for polymerization would be 468 to 470 nm (2).

Number of factors affect the depth of photoactivated cures which include duration, depth and intensity of visible light penetration, filler type and shade, the reflective characteristics of the backing, the mold size, and the optical configuration of the experimental setup (3, 4). While using light cured composite adhesive system, a streamlined bonding process is an important consideration, and the choice of light source is critical. Light curing sources include halogen, plasma arc, argon laser, and light-emitting diode units (5).

During the light cure bonding procedure in dental office, it is a usual routine for orthodontist to switch off the dental chair light. This is done in anticipation that the yellow light of the dental chair may interfere with blue light of the light curing source, this can further influence the bond strength and subsequently increase the bond failure rate. It is stated in the earlier studies that the reduction in the intensity of the polymerizing light source would retard the degree of conversion of the composite material and the mechanical properties of the composite resins are directly in-

Figure 1. Sample after bonding

fluenced by the degree of conversion (6, 7).

If this is true the clinician's anticipation pertaining to the influence of the yellow light of dental chair on the bond strength must also be true. However, the extensive literature survey on bonding in the field of orthodontics showed that there existed a wide lacuna in the research pertaining to the influence of dental chair light on the bond strength of bracket cured, using light cure composite. A study was planned with the aim to determine whether ambient dental chair light from the overhead light source causes any effect on the shear bond strength (SBS) of light cured composite material.

2. MATERIALS AND METHODS

A total number of 60 therapeutically extracted human premolar teeth were collected. All the selected teeth were checked for the intact buccal enamel, with complete absence of visible cracks resulting from extraction and had no caries or restorations. The teeth were divided into two groups comprising of 30 samples in each group. The samples were prepared in a clinical laboratory. They were embedded in the cold cure acrylic block with the help of square shaped mold prepared in putty material. The teeth in each group were given number of that group. The sample were randomly divided in to two test groups as follows

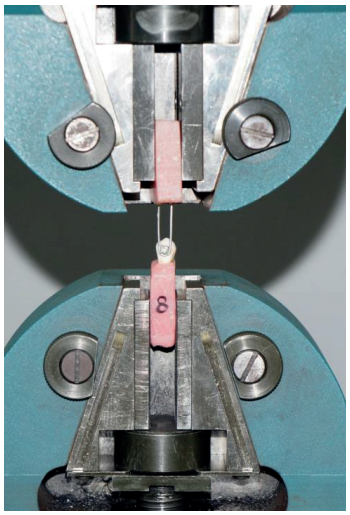


Figure 2. UTM during debonding process. (Sample placed in the cross head)

- Group I - Orthodontic brackets which were bonded to the enamel using light activated adhesive system, keeping the dental chair light in off mode.
- Group II - Orthodontic brackets which were bonded to enamel using light activated adhesive system, keeping the dental chair light switched on.

During the curing procedure the distance between the bracket and LED light was kept at 2 mm and between the bracket and dental chair light, it was kept at 50 cm.

Bonding procedure

To produce a chalky enamel surface, enamel surface was lightly abraded with 600-grit sandpaper for 5 seconds to create a smooth flat surface of enamel, polished for 10 seconds with a rubber prophy cup and fluoride free pumice and water. Rinsed for 10 seconds with deionized water from an air water syringe. Dried for 5 seconds with air from air water syringe, Acid-etched for 20 seconds with 37% phosphoric acid gel (3M Unitek, Monrovia, CA, USA), Rinsed for 10 seconds with deionized water from an air water syringe, dried for 5 seconds with air from an air water syringe, coated with a thin layer of Transbond XT primer (3M Unitek, Monrovia, CA, USA). Stainless steel orthodontic maxillary first premolar bracket (MBT 3M Unitek) was bonded to enamel surfaces in group I and II (Figure 1). Each bracket was placed on the bonding surface using bracket holder and fully seated into position. The excess adhesive was removed and the remainder was cured using the light cure composite resin system.

Those enamel surfaces assigned group I, were cured 20 second each, using a lead based light cure composite resin system with the dental chair light switched off, while in group II light curing was done with the dental chair light switched on. After bonding, the teeth were stored in deionised water at 37°C for 48 hours in incubator. Brackets were chosen randomly, were debonded using a universal testing machine (Tinius Olsen H25KS). A load cell carrying 500 Newton's was attached to the machine. For measuring the shear bond strength, the prepared sample was positioned in lower cross head, with the long axis of the tooth and the bracket base parallel to the direction of load applied. An acrylic jig was made which is gripped in the upper jaw (cross head) and under the gingival wings by adjusting the crosshead. The shear debonding force will be applied to the bracket base in an occlusal-gingival direction at a crosshead speed of 0.5 mm/min (Figure 2). The load was progressively applied till the bracket got detached from the tooth surface and the reading was recorded in Newton for every specimen and then converted into Megapascals (MPa) by using following formula:

(The surface area of the brackets used was 9.81 Smm^2)

The mode of bond failure of each specimen, chosen randomly was examined under a SEM. Based on the amount of adhesive remaining on the tooth, an adhesive remnant index (ARI) score was assigned to each tooth. ARI score was assigned based on Artun J and Bergl (8) and method utilized the

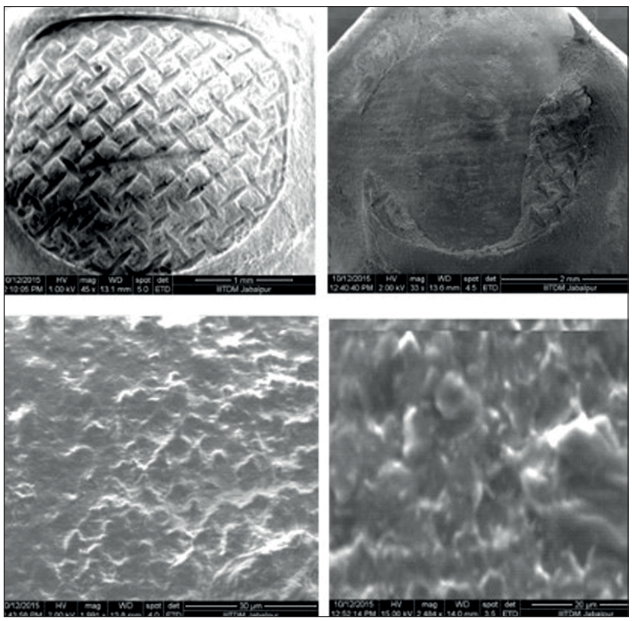


Figure 3. SEM Images of Teeth Surfaces

Light curing groups	Mann whitney U test statistics		
	Mean ranks	Test value	P Value
Without dental chair light (n=30)	21.97	194.000	0.000 (< 0.001), Significant Difference
With dental chair light (n=30)	39.03		

Table 2. Comparison of shear bond strength Group I and Group II Samples.

Light curing groups	Mann whitney U test statistics		
	Mean ranks	Test value	P Value
Without dental chair light (n=30)	29.45	418.500	0.603 (>0.05), Not Significant
With dental chair light (n=30)	31.55		

Table 3. Comparison of adhesive remnant index (ARI) scores between Group I and Group II samples

following scoring system.-

Light curing groups	Shear bond strength (MPa)		
	Mean ± SD	Median	Min-Max
Without dental chair light (n=30)	5.74 ± 1.13	6.10	3.60-7.40
With dental chair light (n=30)	7.71 ± 1.90	6.86	5.30-10.70

Table 1. Mean, standard deviation (SD), median, mimimum and maximum values of shear bond strength in Group I and Group II samples

- 0 - Indicates that no adhesive remained on the tooth in the bonding area.
- 1 - Indicates that less than half of the adhesive remained on the tooth
- 2 - Indicates that more than half of the adhesive remained on the tooth and
- 3 - Indicates that the entire adhesive remained on the tooth with a clear impression of the bracket mesh.

Statistical Analysis

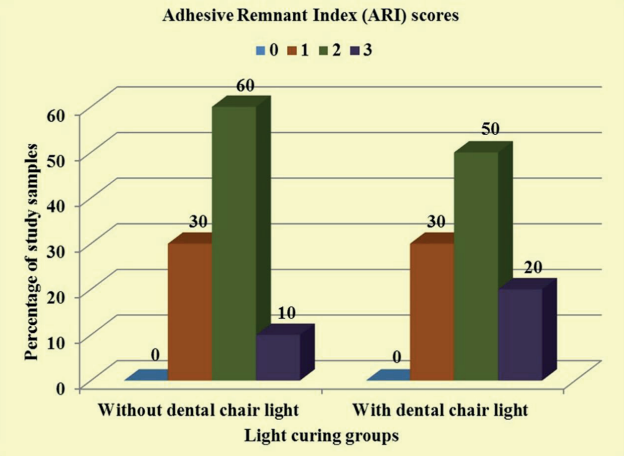
Data of shear bond strength did not follow normal distribution and the adhesive remnant index (ARI) scores were on ordinal scale, so, it was decided to use Mann Whitney U test for comparison of light curing without dental chair light and with dental chair light groups. P value <0.05 was considered statistically significant. Data analysis was done using Statistical Package for Social Sciences (SPSS) v.21 for windows.

3. RESULTS

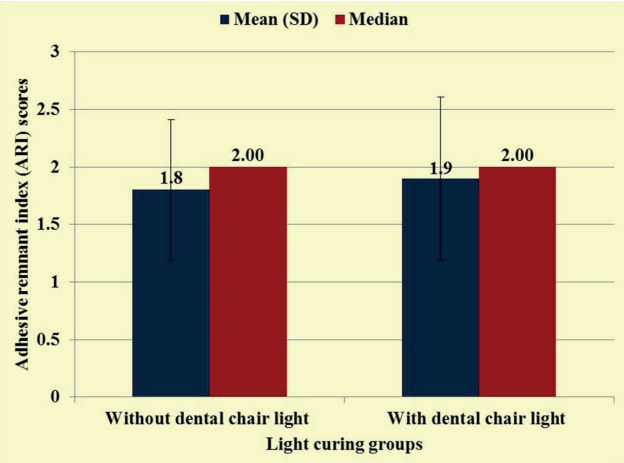
The Mean, Standard Deviation, maximum and minimum values of shear bond strength of the both groups together is represented in Table 1. In group I the mean SBS was 5.74 ± 1.13 which is less in comparison to group II where mean SBS was 7.71± 1.90.

Table 2 depicts the comparison of SBS of both groups. A P value of 0.000 was obtained which was less than the P value set at 0.001. This showed a statistical significant difference between group I and group II for the SBS achieved, with group II where the dental chair operatory light was switched on during the light cure bonding procedure showing greater SBS.

Graph 1 depict the distribution of ARI scores in sample of both groups. In both groups there was a higher frequency of ARI scores of 2, which indicates that in maximum samples of both the groups, more than half of the adhesive remained on the tooth surface.



Graph 1. Distribution of adhesive remnant index (ARI) scores in Group I and Group II samples



Graph 2. Mean, standard deviation (SD) and median values of adhesive remnant index (ARI) scores in Group I and Group II samples

The comparison of ARI scores of both groups is shown in the Graph 2 and Table 3. A P value of 0.603 was obtained which was lower than the set P value (0.05). This showed no significant difference between ARI scores in between the groups.

4. DISCUSSION

Type of light curing devices, type of enamel conditioner, etchant, acid concentration, etching time, composition of the adhesive, bracket base design and bracket materials are the few things which can influence the bond strength (9). The peak wavelength and bandwidth of the curing light, the intensity of the light and the irradiation time also have profound effects on the depth of cure.

In the present study all the variables which could have an effect on shear bond strength such as the human teeth, the etchant, acid concentration, etching time, composition of the adhesive, bracket base design, bracket material, light curing device and the photo activation time were kept constant and similar for both the control and experimental group. Thus the only variable affecting the shear bond strength in this study was the change in intensity due to interference with dental chair light which was the focus of this (in-vitro) investigation.

The current investigation found a significant difference in SBS for the Group I and Group II, due to interference in in-

tensity of curing light. These findings are in agreement with the previous studies (10-16) which have also reported higher shear bond strength due to increase in the intensity of curing light.

In view of the results of the present study it can be appreciated that higher shear bond strength can be achieved when light curing is done when the yellow dental chair light switched on. However, shear bond strength values obtained with both the groups were well within the clinically acceptable range. Same was backed by Reynolds (17) who suggest that minimum bond strength of 5.9 to 7.8 MPa is adequate for most orthodontic treatment during routine clinical use. The clinical conditions may differ significantly from an in vitro setting and constraints of a clinical set up cannot be ignored. It needs to be emphasized that although all the possible variables influencing the results of this study were standardized, the test conditions were not subjected to the rigor of the oral environment, which is the major setback of any in vitro study. In previous literature it is suggested variations in results between studies may be due to differences in research protocol and the technique sensitivity of the materials (17).

The ARI as it is mentioned in the literature may oversimplify the very complex issues of bond failure analysis, but its value in amending the data for the statistical analysis and cross-study comparisons should not be ignored. In addition, the ARI scores are more descriptive observations, these data are helpful in characterizing the bond failure, since there are several interfaces at which fracture may occur.

The ARI scores of the present study indicate adhesive bond failure at enamel adhesive interface and showed that most of the composite remained on the tooth after bracket debonding. This suggests that the weak link is between the metal bracket and the composite. However, there was no statistically significant difference between any of the group's ARI scores. These results are clinically interesting because bonding resin with high ARI scores can exert a protective effect on the enamel during the process of removing the orthodontic accessories, thereby avoiding enamel fracture.

In the current study ARI score 2 was noted in 60 % of samples without dental chair light and 50% with dental chair light sample ,this means that more than half of the adhesive remained on the tooth surface in both the samples. This is in contrast to the reports of earlier studies of fast curing light where less than 10% of adhesive remained on tooth surface (18-21).

The distance between curing light and bracket surface during bonding procedure, can also influence the SBS and ARI scores. In the current study the distance between curing light and teeth surface was kept around 2mm in both the groups. Whereas, dental chair light distance was kept at 50 cm. With these condition our ARI score was 2 in maximum of both the samples. However, in study by Jain et al (11) the ARI score was 3 when the curing light was kept at 2 mm distance from the bracket for conventional LED light. Even the bond strength which was obtained in the study is 21.5 MPa for 2mm distance which is drastically higher than the bond strength obtained in current study. But they have used halogen light for curing, where as in the current study we have used conventional LED light.

The shear test result and the ARI results in the current study prove, that both bonding techniques, either in the presence of dental chair light or in its absence, to be efficient, with a statistically significant difference in SBS between both groups (P V< 0.001).

A clinical Observation during the investigation was that the emission from the dental chair operatory light would initiate polymerization of the composite adhesive resin earlier and thereby create an hindrance during bracket position manipulation, this might result in high bond failure rates during clinical performance.

It can hence be safely concluded that during light curing of composite adhesive resin the dental operatory light should be switched off. Although if accidently left on it would not adversely affect the bond strength.

The most commonly used traditional Orthodontic Bonding procedure is technique sensitive, as it requires absolute humidity control. Failing to do so will lead to contamination of enamel surface which subsequently can decrease the shear bond strength (22). Apart from this the traditional orthodontic bonding procedure is time consuming too (18). As it required 20 to 40 second time for each bracket curing (23). Probable solution to these constraint is the quickening of the curing time. Quickening of the curing procedure is made possible by using of argon laser and xenon plasma light (18, 24). Although these later curing light reduce curing time by one quarter to one third respectively. But in comparison to conventional light curing units these machines are costly which render the unpopularity of these curing units in private dental clinics (25, 26). Based on the results of current study dental chair light in conjugation with LED seems to increase the rate of polymerization thus quickening or fasting the curing time and providing the solution for above mentioned constraints.

Quickening of the curing time can lead to shrinkage of resin. This problem might be seen in case of sample cured with both LED and dental chair light unit together (group II). However, the thickness of adhesive layer and the excess of resin existing at the edge of adhesive area, can absorb some amount of shrinkage. And the shrinkage itself can pull the bracket closer to the enamel which is probably an advantage rather than a disadvantage (27).

In the present study mean shear bond strength of conventional curing light is 5.59 Mpa and with dental chair light unit in conjugation with LED is 7.71 Mpa, this is less than the mean bond strength obtained by the fast curing light systems like plasma or xenon light (28).

The present study highlights that higher SBS can be obtained with least enamel damage when dental operatory chair light was switched on during the light cure bonding procedure. It is recommended that an inexperienced operator should switch off the dental chair light for increased working time, conversely, an experienced operator can keep the dental chair light on for the early initiation of polymerization thus reducing the chances of subsequent salivary contamination.

Though, the study was full proof in controlling all the possible study variables. Nevertheless, it was an in vitro study, the results of study can be more authentic if the same investigation is repeated in an in vivo set up. Further, the study carries the scope to explore the effect of dental chair light on the bonding procedure using the latest light curing units such as

argon laser, xenon and plasma arc curing light.

5. CONCLUSION

It can be concluded that the LED light curing with dental chair light on (group II) produced higher shear bond strength than the light curing without dental chair light (group I). The dental chair is capable of initiating the polymerization. The ARI analysis revealed that the adhesive for most specimens from both the groups remained on the tooth surfaces.

• Conflict of interest: none declared.

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