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Effect of Chairside Light on Shear Bond Strength of Light Cure Resins Used to Bond Orthodontic Brackets: An in Vitro Study

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ABSTRACT

Aim: The present study was conducted to evaluate the effect of chairside light on shear bond strength of stainless steel brackets bonded with light cure composite resins.

Materials and Methods: Fifty premolars were randomly divided into 2 groups; Group 1 was bonded in the presence of chair-side light, Group 2 was bonded in the absence of chair-side light. The samples were transferred into saline to simulate the oral environment. After 1 week they were subjected to shear bond strength testing in the occluso-gingival direction using universal testing machine (Instron).

Results: The results demonstrated the mean shear bond strength of 6.88±1.37 Mpa for Group 1 and 11.81±0.79 Mpa for Group 2. Analysis of paired T-test determined the statistical difference in the mean shear bond strengths between two groups ($p < 0.005$).

Conclusion: The shear bond strength of orthodontic brackets bonded with light cure resins in the presence of chair side light showed a statistically significant difference and was lower than those bonded in the absence of chair-side light. However, the bond strength obtained in the presence of chair-side light were within the range required for orthodontic bonding.

Keywords: Sheer bond strength, light cure resins.

INTRODUCTION

In orthodontics, many factors influence the bonding of bracket to the tooth such as type of etching, type of composites, types of light, time of exposure. In 1970, self-cured composite resins were used for placement of orthodontic brackets. It has a few drawbacks such as polymerization of resin during mixing, unable to manipulate by operator with in the setting time which affects the bracketing accuracy & uneven mixing of the two paste system which affects the bond strength.[1]

In 1976, ultraviolet light-cured materials were introduced and quickly replaced those products that were self-cured.[1, 2] These ultraviolet light-cured materials have the disadvantages of radiation hazards[3] and limited depth of cure.[4, 5] These problems have been largely overcome by the introduction of a blue, visible light-cured composite resin.[6]This light-cured resin is a single paste system that consists of a ketone and an amine as initiators. The ketone, camphoroquinone, is sensitive to blue light at a 470 nm wavelength, which catalyzes the polymerization reaction.[6] Compared with ultraviolet light, visible light has deeper curing

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capabilities, [7-9]and it is more effective through enamel, [9-12]and does not diminish with time or with the intensity of the light source.[11]

Most orthodontic bonding materials use luminous energy for activation like quartz-tungsten-halogen (QTH) visible light, xenon light and light emitting diodes (LED). In a dental office, while light curing of resin materials, we usually shut the chair-side light because an interference of the blue light with yellow dental chair light is suspected, which show effect on the intensity of the light. A reduction in the intensity of the polymerizing light source would retard the conversion of composite material, [13] thereby affecting the mechanical properties of composite resin and reducing the shear bond strength.[14]

The aim of this study was to determine the effect of chair side light (with glass reflector 28,000 lux.) on the shear bond strength of composites used for bonding the brackets.

MATERIALS AND METHOD

This study used 50 extracted permanent premolars- all extractions indicated for orthodontic purpose. After extraction the teeth were cleaned and stored in distilled water and then each tooth was mounted vertically in a self-cure acrylic (DPI) blocks. The samples were divided into two groups and assigned at random into two sets of 25 teeth corresponding to the presence and absence of chair-side light during curing. Bondable stainless steel 0.022” slot MBT premolar brackets (ORTHO ORGANIZERS) with an average bracket surface area[15] of 11.28mm^2 were used. All samples were etched with37% Orthophosphoric acid (ORTHOVITA etchant; Libral traders; New Delhi).

Bonding agent used was ORTHO SOLO™ (SDS Ormco, Glendora; California). Brackets were bonded to the buccal surface of the tooth using composite adhesives (ENLIGHT; Ormco, Glendora; California). Curing was done with a light cure device (LED wavelength of 440-490nm) in the presence or absence of chair side light (LED light with glass reflector 28,000 lux) based on the group. After bonding, the sample was stored in normal saline following which the shear bond strength was tested on universal testing machine (INSTRON).

Inclusion criteria: The criteria for tooth selection included intact buccal enamel, not subjected to any pretreatment chemical agents like hydrogen peroxide, with no cracks due to the pressure of the extraction forceps, and no caries.

Exclusion criteria: carious, gross abnormality, hypoplastic and fractured teeth were excluded in this study.

Extracted teeth are cleansed of soft tissue and after careful debridement the teeth were stored in distilled water at room temperature. Later, 50 selected teeth are randomly divided into two groups of 25 each. Then a custom made mould is prepared by making an impression of wax block (5×5×20) using silicon putty material as shown in fig.1. Then the teeth are embedded in custom made mould using self-cure acrylic resin with its labial and lingual surfaces exposed above the cemento-enamel junction and tooth positioned parallel to the face of the block. For identification purpose of the two groups, we used two different colored acrylic resins.

Fig 1: Putty silicon impression material

Group 1: buccal surfaces of all the teeth were etched with 37% phosphoric acid and rinsed with water and dried for 10 seconds with dry air. Later bonding agent was applied over the buccal surface of all the teeth in the presence of chair side light in a dark room and light cured. Brackets were then bonded to the teeth in the same room in the presence of chair side light as shown in fig. 2. After this procedure, sample was transferred into saline to simulate the oral environment and stored for 1 week.

Fig 2: Brackets were then bonded to the teeth in the same room in the presence of chair side light as shown.

Group 2: the same procedure was repeated in the absence of chair side light as shown in fig. 3. The group 2 sample was also transferred to saline and stored for 1 week.

Fig 3: Same procedure was repeated in the absence of chair side light

After 1 week, the samples were debonded using universal testing machine (instron) at a cross head speed of 5mm per minute. In the upper jaw of the instron machine a metal plate with sharp edge was attached which transferred the force onto the bracket as shown in fig. 4. The load at bracket failure was recorded by a computer assisted instron and the shear bond strength values were calculated in megapascals (Mpa) by dividing the debonded force by the area of the bracket base.

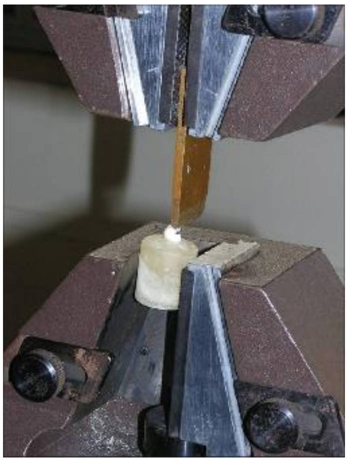

Fig 4: In the upper jaw of the instron machine a metal plate with sharp edge was attached which transferred the force onto the bracket as shown.

RESULTS

The results obtained were as follows.

Group 1	Group 2
5.5Mpa	12.5Mpa
5.9Mpa	12.8Mpa
5.4Mpa	12.4Mpa
5.8Mpa	12.6Mpa
5.3Mpa	12.2Mpa
5.0Mpa	12.1Mpa
5.1Mpa	12.7Mpa
6.7Mpa	13.3Mpa
6.7Mpa	11.8Mpa
6.2Mpa	11.5Mpa
7.2Mpa	11.2Mpa
7.8Mpa	11.4Mpa
7.8Mpa	10.5Mpa
8.2Mpa	10.8Mpa
8.9Mpa	10.9Mpa
8.2Mpa	11.3Mpa
9.0Mpa	10.7Mpa
9.3Mpa	11.3Mpa
6.5Mpa	11.7Mpa
7.2Mpa	12.5Mpa
6.8Mpa	10.5Mpa
7.5Mpa	11.2Mpa
5.8Mpa	12.8Mpa
7.2Mpa	10.3Mpa
8.3Mpa	11.7Mpa

STATISTICAL ANALYSIS

Statistical analysis was done using T-test for individual specimens and for both groups. Statistical test were performed at a P > 0.005 level of significance. The descriptive statistics on shear bond strength for each experimental group were shown in Table 1 which reveals that the mean bond strength for group 1 is 6.88 ± 1.37Mpa and the mean bond strength for group 2 is 11.81 ± 0.79Mpa. T Test was performed in order to compare the two experimental groups and the results are shown in Table 2.

Group statistics illustrated in Table 2 revealed significant difference between the mean values of shear bond strength (SBS) of the two groups with the highest mean value found at group 2 (In the absence of chair-side light), while the lowest was seen in group1(In the presence of chair-side light).

Table 1: Descriptive statistics for shear bond strength.

	group	N	Mean	Std. Deviation	Std. Error Mean
strength	group 1	25	6.8850	1.37469	.30739
	group 2	25	11.8100	.79862	.17858

Table 2: Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Strength	Equal variances assumed	7.578	.009	-13.854	38	.0001	-4.92500	.35550	-5.64466	-4.20534
	Equal variances not assumed			-13.854	30.513	.0001	-4.92500	.35550	-5.65051	-4.19949

DISCUSSION

Achieving effective and lasting bond between enamel and orthodontic brackets is essential in day to day orthodontic practice. The bonded brackets should be able to withstand forces generated by treatment mechanics and occlusion and it should allow easy debonding without damage to the enamel. It was also reported that maximum tensile bond strength of 5.9 to 7.9Mpa would be adequate to resist treatment forces but Invitro tensile strength level of 4.9Mpa have proved clinically acceptable.[16]In 1975; Reynolds[16] reported that shear bond strength in range of 5.9 to 7.8Mpa were needed to sustain normal oral and orthodontic forces. A lot of factors affect the bond strength of orthodontic brackets and they have been studied in detail in literature. However, very few studies have been reported in literature regarding the influence of chair-side light during bonding in orthodontics. Orthodontic brackets can be bonded on the teeth individually, or all at one time and the chair-side light is usually switched off during the curing procedure. But switching off the chair-side light during curing can sometimes result in reducing the visibility of the brackets and teeth and the light cure fiber optic tip inadvertently touching the adjacent brackets and displacing them.

In 2012, Bandish parekh[17] reported that there is no change in mechanical properties of composite resin during curing in the presence of chair-side light. In our study, the bond strength values observed were 6.88 ± 1.37 MPa for Group 1 and 11.81 ± 0.79 MPa for Group 2 showing that there was a statistically significant difference with lower bond strengths in the presence of chair-side light. This was in accordance to the article published by McCade et al.[13], in 1989 reported that setting of composite is independent of intensity when the intensity of curing light is about 550lux. Below this critical value, the setting reaction of composite fell markedly with decreasing intensity. Ferracane JL.[14] In 1985 reported that hardness of the composite correlates well with increase in degree of polymerization of the composite. So, the presence of chair-side light might have reduced the setting reaction there by reducing the bond strength. However, the bond strengths obtained in the presence of chair-side light fall within the clinically acceptable limits.

CONCLUSION

The shear bond strength of orthodontic brackets bonded with light cure resins in the presence of chair side light showed a statistically significant difference which was lower than those bonded in the absence of chair-side light. However, the bond strength obtained in the presence of chair-side light was within the suitable range required for orthodontic bonding.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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