ORIGINAL ARTICLE

LED LIGHT TIP DISTANCE EFFECT ON SHEAR BOND STRENGTH OF ORTHODONTIC BRACKETS: IN-VITRO STUDY

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ABSTRACT

Various attempts have been made to improve the shear bond strength of brackets. Aim of current research was to compare the mean shear bond strength (MSB) of adhesive cured at 0mm and 5mm curing light tip distances. This in-vitro comparative research involved 40 extracted human bicuspids that were classified into 2 groups of 20 teeth each, using random number table method. Group A, teeth brackets were cured at light tip distance of 0 mm and Group B, at 5 mm distance. After bonding with standardized protocol, all samples were stored and subsequently tested for MSB using universal testing machine. t-test was used for comparison of MSB in both the groups. Duration of this study was January 2017 to October 2017. Results showed that MSB of metal brackets cured at 0mm and 5mm light curing tip distance was similar. It was concluded that there was statistically insignificant difference of curing distance on mean shear bond strength of orthodontic brackets.

Key Words: *Shear bond strength; LED; Curing distance.*

INTRODUCTION

Among different available bonding adhesives, composite resins are preferred now for bonding orthodontic brackets.[1] Orthodontic composites are blend of organic matrices and inorganic filler particles.[2] Orthodontic composites can be classified as light cure and self cure composites, however, light cure resins are commonly used for bonding orthodontic brackets.[3]

Light curing units (LED) was introduced in 1980s by Mills. LED are curing lights that consisted of various semiconductors joined together to generate blue light.[4] LED got advantages of low power, 10000 hours life, small size, and resistant to shock and vibration.[5]

According to literature, bonded brackets must have bond strength 6 and 8 MPa to successfully bear orthodontic forces.[6] Different factors affect shear bond strength of orthodontic brackets, such as, curing time, curing distance, adhesive type, teeth related - source related and various other factors.[7] No differences in MSB of orthodontic brackets were found among commercial LED units and conventional halogen units.[8] Recently, high power LED lights have been introduced that decreased the curing time. More SBS occurred with increase in curing time, Similarly LED and halogen units showed higher MSB as the curing time was increased.[9] Results from previous literature showed that, using LED units, there is no influence of zero mm, three mm and six mm curing distances, on shear bond strength.[10]

Rationale of current study was to measure MSB by various light curing tip distances. Research data is publishing in this regard but results may be different in present study because of difference in composition of the orthodontic composite material used, different model of light source used and use of human extracted teeth instead of bovine teeth. There are certain differences in human and bovine teeth such as average diameter of enamel crystallite of bovine is larger, calcium content is higher, micro leakage is more and radiographic enamel density of bovine enamel is more than human extracted teeth.[11]

Present research was aimed to compare the MSB of the orthodontic bracket cured at different curing light tip distances of 0mm and 5mm. Our hypothesis was that, 0mm will cause a greater MSB as compared to 5mm light curing tip distance.

METHODOLOGY

This In-vitro, comparative study was conducted at Orthodontic Department, Faisalabad Medical Univer-

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sity and de'Montmorency College of Dentistry. Sample size of 40 was estimated using 95% confidence level, 80% power of test with expected MSB 19.9±5.7 MPa in 0 mm group and 9.6±5.3 MPa in 5mm group.10 Duration of this study was January 2017 to October 2017.

Following teeth were included: Human bicuspids extracted for orthodontic reasons, no teeth wear of extracted teeth and having intact buccal surface. Following teeth were excluded: Any dental pathology involving buccal surface, history of orthodontic bonding.

As per selection criteria, 40 extracted human premolar teeth were preserved in 0.1% thymol. Teeth were divided randomly into two groups of 20 teeth each, by using random number table method. Using LED unit, Group A teeth brackets were cured at the light tip distance of 0mm i.e. light source tip was at the edges of bracket with no distance, and Group B brackets were cured at light tip distance of 5mm for the time recommended by manufacturer. Distance of 5mm was measured by calibrated vernier caliper.

The teeth were initially cleansed and polished. Each tooth was etched for half a minute followed by rinsing and air drying. Orthodontic primer (3M-Unitek) was light cured. Premolar brackets (3M-Unitek) with a bracket base area of 11.35 mm2 were taken and bonded using light cure orthodontic adhesive (3M Unitek). Teeth were stored in distilled water and thermocycled.

TABLE 1: DESCRIPTIVE STATISTICS OF MSB (MPa)

Mean shear bond strength (MPa)	N	40
	Mean	17.83
	SD	4.37
	Minimum	11.00
	Maximum	20.00

TABLE 2: COMPARISON OF MSB (MPa) IN BOTH THE GROUPS

		Study Groups	
		Group 0mm	Group 5mm
Mean shear bond strength (MPa)	n	20	20
	Mean	17.90	14.76
	SD	3.35	3.26

p-value = 0.150 (Insignificant)

The shear bond strength was measured via universal testing machine at 0.5mm/minute, using the formula: Shear strength (MPa) = Debonding force (N)/ bracket base area (mm2) and 1 N/mm. The MSB was measure and presented in form of mean, SD. t-test was applied for comparison of MSB in 2 groups. Level of significance was determined at $p \leq 0.05$.

RESULTS

Total 40 extracted premolars were included in this study. The mean value of shear bond strength was noted as 17.83±4.37 MPa (Table 1). The mean and SD for the MSB of 2 groups were presented as shown in Table 2. The t-test comparison indicated insignificant difference between the two groups ($p = 0.150$). The 0mm had greater MSB when compared with 5mm group, but difference was statistically insignificant (Table 3).

DISCUSSION

The degree to which composite resin cure depends on the intensity and quality of curing units to which they are exposed and the curing time. Other factors such as composite type, its shade, density of adhesive used, enamel density, curing tip distance and its orientation, and the dimensions of the curing tip may also influence bond strength of brackets.[12-14]

Current research was conducted to determine the MSB of bracket cured with different curing light tip distances i.e. 0mm and 5mm. According to results statistically there was insignificant difference between the two study groups in MSB. This may be due to the fact that orthodontic curing lights are collimated with small working ranges, leading to a less acute decrease in irradiance with increasing distance.[15]

Results are contrast with findings of Murchison and Moore, who showed that hardness of resin liners was better at a distance of 3mm from the cavity floor than at 0mm or 6mm.[16] Results from other previous literature also showed increased leaching of residual monomer with increased light tip distance.[17] Results are in agreement with AsliTopalogluAk who concluded that efficiency of the curing unit and proper curing time is more important.[18]

Amit Jain demonstrated in their study that shear bond strength value was inversely related to increasing light source distance from 2 to 6 mm,[19] which is in contrast with other results. Similarly, Aguiar showed that mechanical properties decreased significantly with increasing distance from the light guide.[20] Sivazero et

TABLE 3: COMPARISON OF 2 GROUPS

	t-test					
					95% Confidence interval of the Difference	
	t	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Shear bond strength (MPa)	0.821	0.150	3.0411	0.7866	1.0345	3.9900

al concluded that it is best to place curing tip as close to the composite as possible to achieve best cured composites.[21] Retamoso concluded that the shear bond strength was not affected by light source nature.[22]

One shortcoming of the current study was that it was in in-vivo conditions, which cannot reproduce the in-vitro oral conditions.[23] Clinically, intraoral contamination, saliva, thermal changes, and other factors such as orthodontic forces can influence MSB.[24-25] Despite this shortcoming, the result of the current study suggests that when using LED for bonding orthodontic brackets, 0mm or 5mm distance produce equally strong bonds.

CONCLUSION

There was statistically insignificant influence of curing distances (0 mm vs. 5 mm) on mean shear bond strength of orthodontic brackets bonded with composite adhesives.

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