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ANGULATION OF THE LIGHT CURING UNIT TIP AND ITS EFFECT ON THE SHEAR BOND STRENGTH OF AN ORTHODONTIC BONDING ADHESIVE.

Research Study

ABSTRACT :

Objective: The purpose of this study was to assess the effect of the angulation of the light cure tip on shear bond strength of an orthodontic bonding adhesive. Methodology: One hundred and fifty extracted premolarsobtained, were grouped into three groups A, B and Cconsisting of 50 samples each. Metal brackets werebonded in a standardized manner using 3M Transbond XT. The orthodontic adhesives were cured with the blue LED (Ivoclar - LEDITION) light with acuring time of 30 seconds using three different angulations of 0^0,45^0 and 90^0 to the long axis of the tooth at a standardized distance of 3mm--5mm.The shear bond strength was measured using an Instron machine(Universal Testing Machine).Results: The data obtained was computed and statistically analyzed using One-Way ANOVA followed by Tukeys' HSD Post Hoc Analysis. Conclusion:The mean shear bond strengthforGroup A (0^0 angulation) was highest followed by Group B(45^0 angulation) and the lowest was shown by Group C (90^0angulation).

KEY WORDS : Light curing tip angulation, Shear Bond strength, Orthodontic adhesive.

Dr. Bharathi. V. S.
Senior Lecturer, Dept of Orthodontics,
Rajarajeswari Dental College and Hospital.

Dr. Dharmesh. H. S.
Associate Professor, Dept of Orthodontics,
Rajarajeswari Dental College and Hospital.

Dr. Kiran H.
Professor, Dept of Orthodontics,
Rajarajeswari Dental College and Hospital.

Dr. Sheela N. V.
Associate Professor, Dept of Conservative Dentistry and Endodontics
D.A.P.M. R. V. Dental College and Hospital.

Corresponding Author :
Dr. Dharmesh. H. S.
Associate Professor, Dept of Orthodontics,
Rajarajeswari Dental College and Hospital

INTRODUCTION :

In orthodonticpractice,it is essential to obtain a reliable adhesion between an orthodontic bracket and tooth enamel.Light activation is accomplished with the blue light at a peak wave length of about 470nm,which is absorbed usually by a photo activator, such as camporoquinone.The degree of polymerization varies according to the distance and angulation from the surface of the composite to the light source. Depth of cure decreases significantly with the increase in distance and variation in the angulation of the light curing tip.[1]

Mills was the first to suggest the use of the LED in orthodontics.[2]LED based light sources have several advantages in comparison to the other light cure units,such as small size, decreased weight,economic, decreased heat and noise generation, increased life source of the radiation, decreased power consumption and decreased light emitting spectrum with total camphoroquinone absorption which is in the wavelength of 470nm.[2,3]

Bonding of orthodontic brackets was started way back in 1960s using the enamel acid etch technique.[4]At that time, only auto-polymerizing materials were available,with the introduction of the light activated systems, orthodontists now have sufficient working time to position the bracket on the enamel surface and remove the excess materials. This evolution has allowed the emergence of several other bonding methods using different composites.[5] TransbondXT Light Cure Adhesive uses light cure technology to provide additional working time to ensure accurate bracket placement.The viscosity of Transbond XT adhesive is designed to prevent adhesive run-on and bracket skating that reduces adhesive waste. Quick cure provides immediate archwire tie-in so that patients andstaff can experience shorter bonding appointments.[6]

There are very few studies available on the importance of the angulation of the light curing tipwhich is a very important factor in obtaining an optimal shear bond strength irrespective of the adhesive used for orthodontic bracket bonding.Thus, the purpose of this study was to evaluate the effects of the different light curing unit tip angulation on the shear bond strength of the orthodontic adhesive(Transbond XT) cured with the blue light emitting diode light curing unit.(Ivoclar-LEDITION).

MATERIALS AND METHODOLOGY :

Extracted human premolar teeth were collected from patients undergoing orthodontic treatment where

extraction waspart of the treatment plan.The inclusion criteria for selection of the premolars were, intact enamel with no hypoplastic or developmental defects, no caries, and no cracks caused by the pressure of the extraction forceps.One hundred and fifty premolars were selected and cleaned with hydrogen peroxide solution for soft tissue removal and stored in 0.5% aqueous chloramine -t solution as adecontaminant ata temperature range of 4^0c-8^0c for a period of one week .The premolarswere than randomly allocated to 3 groups A, B andCcontaining fifty samples each. The collected samples were later stored in 3 separate containers filled with distilled water at a room temperature of 24^0c-26^0c.Later the teeth were embedded individually in cold curing fast setting acrylic (fig 1). Each tooth was mounted in such a way that the labial surface was parallel to the wall of the mould.

The mounted premolar samples were acid etched using unitek etching gel (3M ESPE) of 37% phosphoric acid for 30 seconds and later rinsed with water thoroughly and air dried using oil and moisture free air source.Followed by priming of the tooth surfaces done by coating a uniform thin layer of Transbond XT primer on the tooth surface to the bonded. Since Transbond XT primer acts as awetting agent, thus only a very thin film of primer is required. A small amount of Transbond XT adhesive paste (fig 2) is applied on to the bracket base and immediately placed the bracket on the

Fig 1
Premolar teeth mounted on cold cure acrylic

Fig 2
Transbond 3M XT Adhesive Etchant and Primer

Fig 3
LED Light curing unit (Ivoclar – Ledition)

Fig 4
Curing of premolar bracket at an angle of 0^0 to the long axis of the tooth.

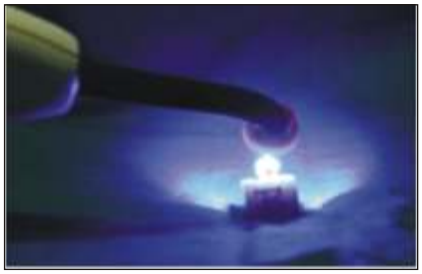


Fig 5
Curingof premolar bracket at an angle of 45^0 to the long axis of the tooth.

Fig 6
Curing of premolar bracket at an angle of 90^0 to the long axis of the tooth.

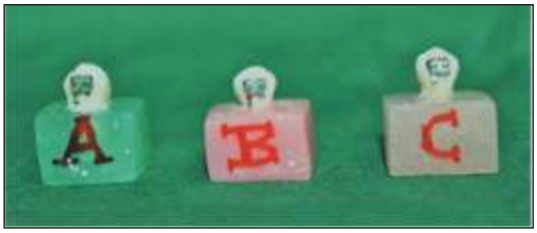


Fig 7
premolar teethbonded with metal brackets using three different angulations.

Fig 8
Shearing force applied by Instron machine on mounted premolar teeth.

tooth surface and lightly adjust the final position of the bracket on the tooth and press bracket firmly to seat it in position and gently remove the excess adhesive from around the bracket base without disturbing the bracket position. Ivoclar light curing unit LEDITION (fig 3) was used for curing group A samples at an angle of 0^0 to the long axis of the tooth (fig 4), group B samples cured at an angle of 45^0 to the long axis of the tooth (fig 5), and group C samples cured at an angle of 90^0 to the long axis of the tooth (fig 6).

A specially designed debonding jig was used to facilitate parallelism of the debonding force direction and subsequently tested in a shear mode on a universal testing machine.(INSTRON ,NORWOOD,USA) (fig 8) Shear bond strength was determined using the formulae SBS=F/A.Data was computed and statistically analyzed using the One-Way ANOVA followed by Tukeys' HSD Post Hoc Analysis.

RESULTS :

Table 1 : Angulation of the light curing tip to the long axis of the tooth in three different directions which is Group A (0^0 angulation), Group B (45^0 angulation) and Group C (90^0 angulation) 50 samples each (total 150 samples) were obtained to evaluate the shear bond strength of the orthodontic light cure adhesive with the above mentioned 3 different light curing angulations.

STATISTICALANALYSIS :

Statistical Package for Social Sciences [SPSS] for Windows, Version 22.0. Released 2013. Armonk, NY: IBM Corp., was used to perform statistical analyses.

Descriptive Statistics : Descriptive analysis includes expression of Shear bond strength [in MPa] between 03 groups. (Group A, B&C)

Inferential Statistics : One-way ANOVA followed by Tukey's HSD post hoc analysis was used to compare the mean shear bond strength [inMPa] between different groups. The level of significance [P-Value] was set at $P<0.05$

The results obtained were tabulated using One-Way ANOVA followed by Tukeys' HSD Post Hoc Analysis, where Group A (0^0 angulation) showed a mean value of 12.34 and a standard deviation of 0.57 ,Group B (45^0 angulation) showed a mean value of 9.72 and a standard deviation of 0.84, and for Group C (90^0 angulation) showed a mean value of 7.03 and a standard deviation of 0.58 with an overall 'F' value of 805.603 and P value being less than 0.001 and all three groups being statistically significant. (Table 2, 3)

Sl.	GROUP A (0^0angulation)	GROUP B (45^0angulation)	GROUP C (90^0angulation)
01	12.9	10.5	6.2
02	11.8	10.7	7.8
03	12.3	9.0	6.3
04	13.2	10.5	6.7
05	12.1	10.7	6.3
06	11.9	9.0	7.8
07	11.7	10.8	6.5
08	12.0	9.2	6.3
09	11.8	9.4	6.7
10	13.0	10.2	7.8
11	12.3	9.2	6.7
12	12.5	10.9	6.4
13	11.5	9.4	6.8
14	12.7	10.3	7.7
15	12.4	9.5	6.8
16.	12.2	9.7	6.4
17	13.3	10.4	7.7
18	13.0	9.6	6.5
19	13.2	9.5	6.4
20	12.4	8.0	6.8
21	12.0	8.2	7.7
22	12.8	10.7	6.9
23	11.8	8.1	6.4
24	11.5	10.9	6.0
25	11.7	8.3	6.9
26	13.2	8.2	7.7
27	12.0	9.7	6.5
28	11.8	10.9	6.5
29	13.2	9.5	7.0
30	12.2	8.7	6.9
31	13.0	10.9	7.8
32	12.0	8.9	7.1
33	13.1	8.8	7.7
34	12.4	10.9	6.0
35	13.2	9.0	6.0
36	13.1	10.3	7.2
37	11.7	10.4	7.3
38	12.7	10.1	7.3
39	13.3	8.7	7.4
40	12.7	10.1	7.5
41	12.8	8.7	7.6
42	13.0	10.2	7.4
43	11.7	9.9	7.6
44	12.0	9.7	7.5
45	12.2	9.8	7.4
46	13.2	10.0	7.7
47	12.2	9.8	7.5
48	13.4	10.4	7.8
49	12.7	9.7	7.7
50	12.7	10.2	7.1

TABLE : 1

Groups	N	Mean	SD	Std. Error	Min	Max	F	P-Value
0^0 Angle	50	12.47	0.57	0.08	11.5	13.4	805.603	<0.001*
45^0 Angle	50	9.72	0.84	0.12	8.0	10.9		
90^0 Angle	50	7.03	0.58	0.08	6.0	7.8		

Table 2

Comparison of mean shear bond strength between three different groups using One-Way ANOVA followed by Tukeys' HSD Post Hoc Analysis.

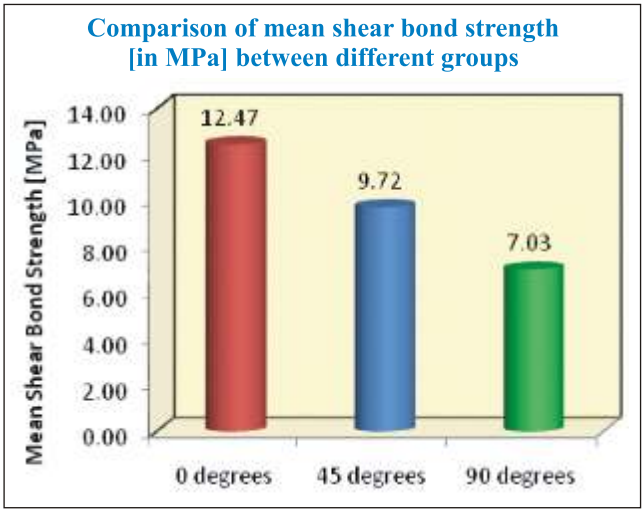
Group (I)	Groups (J)	Mean Diff	95% CI of the Diff		P-Value
			Lower	Upper	
0^0 Angle	45^0 Angle	2.75	2.43	3.07	<0.001*
	90^0 Angle	5.44	5.12	5.76	<0.001*
45^0 Angle	90^0 Angle	2.69	2.37	3.01	<0.001*

* - Statistically Significant

Table 3

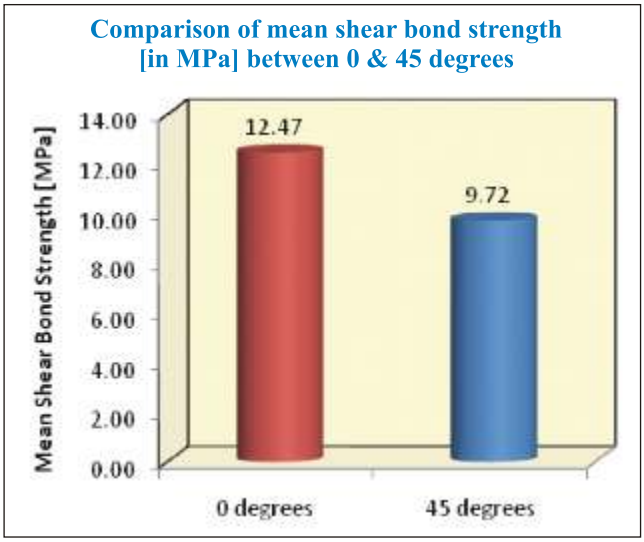
Multiple comparison of mean difference between groups using Tukey's HSD post hoc Analysis.

Multiple comparison of mean difference between all the three groups using Tukeys' HSD Post Hoc analysis was done.Comparison between the 0^0 angulation and 45^0 angulation showed a mean difference of 2.75 with the upper limit of 3.07 and lower limit of 2.43 and the p value is less than 0.001 and is statistically significant (Table:3& Graph 2). Comparison between the 0^0 angulation and 90^0 angulation showed a mean difference of 5.44 with the upper limit of 5.76 and lower limit of 5.12 and the p value is less than 0.001 and is statistically significant (Table : 3 & Graph 3).Comparison between the 45^0 angulationand 90^0angulation showed a mean difference of 2.69 with the upper limit of 3.01 and lower limit of 2.37 and the p value is less than 0.001 and is statistically significant (Table :3 & Graph 4).



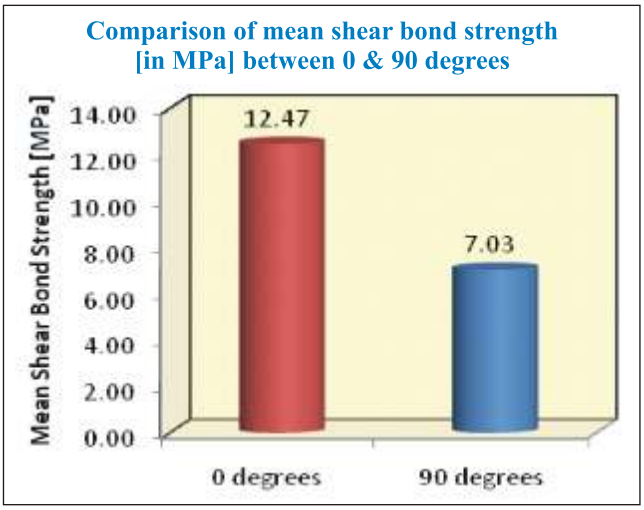
Graph 1

The mean values obtained for 0^0angulation is 12.47, 45^0 angulation showed a mean value for 9.72, and 90^0 angulation showed a mean value of 7.03.



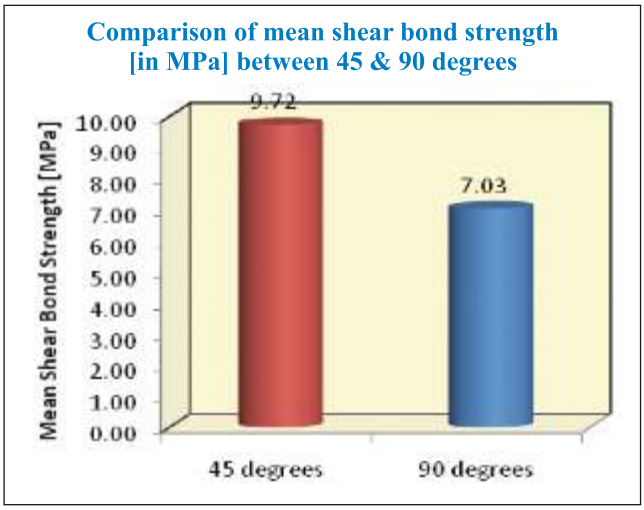
Graph 2

Comparison of the mean shear bond strength between 0^0 angulationand 45^0 angulation showed a higher mean shear bond strength for 0^0 with a value of 12.47 whereas, 45^0 showed a lower value of 9.72.



Graph 3

Comparison of the mean shear bond strength between 0^0 angulationand 90^0 angulation showed that 0 degrees had a high mean shear bond strength of 12.47 and 90 degrees showed a shear bond strength of 7.03.



Graph 4

Comparison of mean shear bond strength between 45^0 angulation and 90^0 angulation showed a higher mean value of 9.72, whereas 90^0 angulation showed a mean value of 7.03 which is less than the 45^0 angulation.

DISCUSSION :

Studies using shear bond strength tests arefrequently difficult to be compared because of severalvariables such as type of light sources, exposuretime, adhesive system used, enamel characteristics,and different methodological approaches.[2]

In a study done by U.A.Yusoff et al on the effect of the light curing tip angulations on the shear bond strength of an orthodontic adhesive showed no significant difference in the mean shear bond strengths when cured at 3 different angulations of 0^0, 45^0 and 90^0.[1]The mean shear bond strength for the orthodontic adhesive curing at the angulations of light curing tip of $0^0$was 3.55 MPa ± 2.65, $45^0$was 4.56 MPa ± 2.43 and 6.17MPa ± 4.85 for 90^0angulation , which is in contrary to the result obtained in this study which showed a highestshear bond strength of 12.47+-0.57 for 0^0 angulation followed by ashear bond strength of 9.72+-0.84 for 45^0 angulation and theleast shear bond strength of 7.03+-0.58 was seen in 90^0 curing tip angulation.[1]

In a study conducted by Z.Radzietal, to investigate the light intensity of selected light curing unit with varying distance and angulation of the light curing tip and lightmeter, it was found that there was no significant difference between 45^0 and 60^0 angulation between the light curing tip and the lightmeter. It was noted that the degree of polymerization also varies according to the distance from the surface of the composite to the light source, Depth of cure decreases significantly as this distance increases. The ideal distance of the light source from the composite is 1 mm, with the light source positioned 90^0 from the light composite surface. As the angle diverges from 90^0 to the composite surface, the light energy is reflected away and penetration is greatly reduced. However, the decrease in light intensity is significant when compared to the light tip being placed perpendicular (90^0) to the aperture of the light meter.[7]

CONCLUSION :

Angulation of the light curing tip and distance plays a very important role in obtaining optimum adhesion in orthodontic bonding. In this study3 different light curing unit tip angulations were considered which were 0^0, 45^0 and 90^0showed that light curing unit tip angulated at 0^0angulation to the long axis of the tooth showed a maximum shear bond strength, followed by 45^0 angulation and the least with 90^0 angulation to the long axis of the tooth when cured from a standardized distance of 3mm-5mm from the bracket.

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