Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v30i9.2788

COMPARATIVE EVALUATION OF BOND STRENGTH AND ARI BETWEEN STAINLESS BRACKETS AND MONOCRYSTALLINE BRACKETS AT VARIOUS CURING DISTANCES

Dr Marie Asha Ambroise[1*], Dr Pradeep Babu Kommi[2], Dr. M. Senthil Kumar[3], Dr Nanda Kumar. A[4], Dr Abdul Khader.K[5]

[1*]Senior Lecturer, Department Of Orthodontics &Dentofacial Orthopaedics, Sri Venkateshwaraa Dental College,13 A, Pondicherry Villupuram Main Road,Ariyur, Puducherry 605102Ph no :8754173078 Email id: ashaorthodontist@gmail.com, OrcidID : 0000-0002-1450-5144
[2]Consultant orthodontist, Apollo dental clinic, Nellore, Andhra Pradesh.Ph no: 9908645099 Email : drpradeepkommi@gmail.com
[3] Former Professor, Indira Gandhi Institute Of Dental Sciences,Pondicherry.Consultant orthodontist, Ph No: 9443050679 Email: arunaident@gmail.com
[4]Professor, Department of Orthodontics and Dentofacial Orthopaedics,Meenakshi Ammal Dental College, Chennai.Ph : 9444066099 Email: araninandu@gmail.com
[5]Dr Abdul Khader K, Assistant Professor, Department of Oral Medicine and Radiology, Mahatma Gandhi Postgraduate Institute Of Dental Sciences, Ph: 9787127503Email : khaders19@gmail.com

***Corresponding Author:**Dr Marie Asha Ambroise
*****Senior Lecturer, Department Of Orthodontics &Dentofacial Orthopaedics, Sri Venkateshwaraa Dental College,13 A, Pondicherry Villupuram Main Road,Ariyur, Puducherry 605102Ph no :8754173078 Email id: ashaorthodontist@gmail.com, OrcidID : 0000-0002-1450-5144

Abstract

Aim: This study aimed to evaluate the shear bond strength of stainless steel brackets and radiance plus ceramic brackets by curing at varying distances of 0mm, 5mm, 10mm using high-intensity light cure unit and also to evaluate the adhesive remnant index (ARI) scores at the site of bond failure.

Material & Methodology: 120 premolars were procured. 60 stainless steel brackets and 60 radiance plus brackets were referred to as groups A and B, respectively. Group A consisted of stainless steel bracket which were subdivided into group A1, group A2, and Group A3 based on the light curing distance of 0mm, 5mm, and 10mm, and similarly group B were subdivided into group B1, B2, and B3 based on the curing distances. The brackets were bonded to the tooth surface after etching the enamel with 37% of phosphoric acid (D-tech) and using Transbond XT adhesive. The brackets were bonded to the tooth surface. Curing was done using 3M ESPE ELIPAR light curing unit of 1200millwatt/cm sq intensity. Debonding was done using Instron Universal Testing Machine to check for the shear bond strength (SBS). The debonded brackets were subjected to a stereomicroscope of 20X magnification to check the Adhesive Remnant Index (ARI) and the results obtained were tabulated and statistical analysis was done.

Results : The shear bond strength (MPa) for group A1, group A2, group A3 were 23.06±1.83, 20.56±2.13, 14.09±2.52 respectively and for groups B1, B2, B3 were 31.38±1.54, 28.29±1.36

,24.46±2.03 respectively. It was found that group B has superior bond strength compared with group A at all distances and it was statistically significant.According to the ARI evaluation, at 0mm distance the bond failure for both the groups were observed at bracket adhesive interface and at 5mm and 10mm distances the bond failure was observed at the enamel adhesive interface

Conclusion: The shear bond strength (SBS) of the radiance plus bracket was found superior than the stainless steel brackets, and the bond strength obtained at all three distances for both brackets was clinically accepted. The ARI at 0mm exhibited bond at the enamel adhesive interface for both brackets and at 5mm and 10mm, it exhibited bond at the bracket adhesive interface.

Keywords: bond strength, ARI scores, curing distance, monocrystalline brackets, stainless steel brackets

Introduction:

Bunocore[1]and Neumann's contribution of bonding in orthodontics has paid its way into the orthodontic treatment world and it plays a vital role in the entire treatment procedure. The innovations done in the materials used in the treatment procedures are mainly to increase the quality of the treatment and to prevent contamination and cross-infection among patients. The bond strength of orthodontic brackets has significant role in deciding the success of the treatment and the ideal bond strength is in the range of 6-8 MPa.[2] The factors deciding on the bond strength are by the bracket materials, bracket base design, adhesives, and the wavelength of the light-curing unit.

Mills introduced LED light curing units as a polymerizing light source in 1995. Currently, some high-power LED curing units can emit light radiation with the intensity of 1600-2000YmW/cm2, allowing shorter exposure times of six seconds for metal brackets. This reduces the working time. The LED light used in our study is elipar 3M ESPE[3], which has high-intensity wavelength of 1200mW/cm2, and studies have shown that the intensity of curing light travels to a distance of 7mm depth.

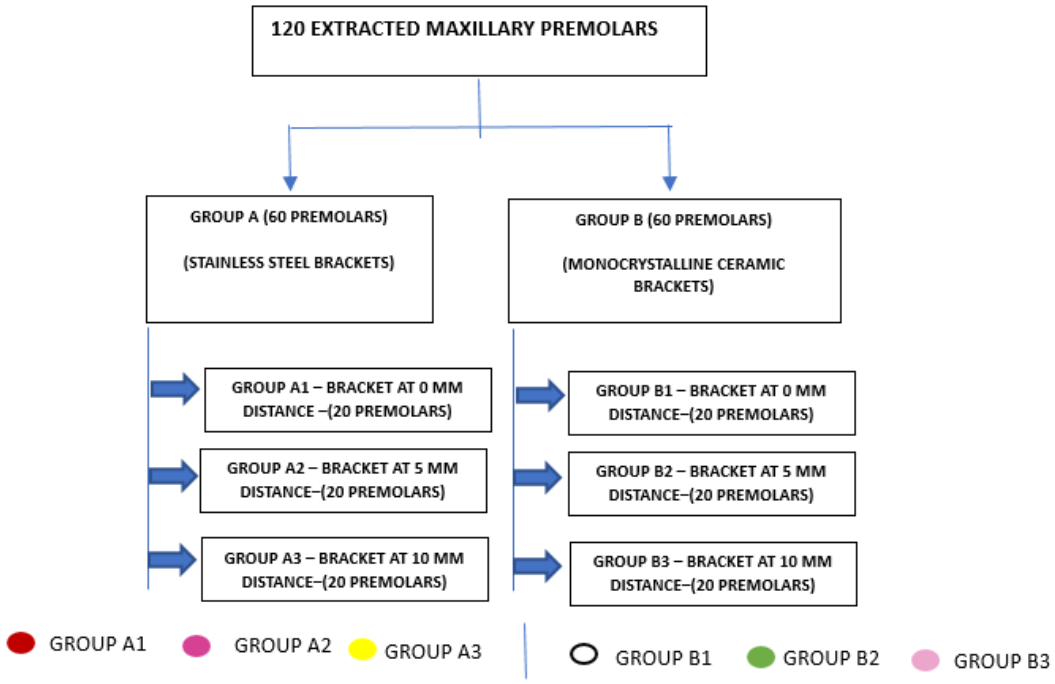
Cross-contamination in orthodontics has become a major concern due to the increase of covid and other viral diseases. In orthodontic procedures, human-to-human transmission of SARS-CoV-2 occurs predominantly through the respiratory tract via droplets, secretions (cough, sneeze), and or direct contact, where the virus enters the mucous membrane of the mouth, nose, and eyes[4.] The virus can remain stable for days on plastic and stainless steel. Hence, contamination via light curing tips is high and precautions in preventing cross-contamination should be taken.

In this study, we would like to evaluate the influence caused by varying the distances of the light cure unit and its effect on bond strength and to evaluate the site of failure

Aims

The study aimed to evaluate the shear bond strength of stainless steel brackets (American Orthodontics, WI, Sheboygan) and monocrystalline ceramic brackets (American Orthodontics, WI, Sheboygan) by curing them at various distances of 0mm, 5mm, and 10mm using a high-intensity light cure unit of 1200millwatt/cm sq intensity, and also to evaluate the adhesive remnant index (ARI) scores at the site of bond failure.

Materials And Methodology:



This study was conducted at Indira Gandhi Institute Of Dental Sciences , Puducherry.
The study isapproved by Institutional Review board (CODE:IGIDSIRB2015NDP09PGMAODO) and Institutional Ethical Committee (CODE: IGIDSIEC2016NDP09PGMAODO).

The samples were divided into group A which is the stainless steel group and group B which is the monocrystalline ceramic group. Based on the varying distances of 0mm, 5mm, and 10mm, the groups were subdivided in group A1, A2, A3 and B1, B2 and B3 respectively . The premolars were placed on a customized jig where the distance was measured from the base of the bracket and curing was done for 15 sec using high-intensity LED light (3M ESPE ELIPER) of wavelength 1200m/watt centimetre square (Fig 1). Each specimen was stored in a container for 24 hours. The shear Bond Strength between the two groups was tested using an Instron Universal Testing Machine (ABS INSTRON 338266216) at the weight of 1KN(Fig 2). The brackets were debonded to evaluate the Adhesive Remnant Index scores as per Alper OZ et al 2013. The bracket base was evaluated under a stereomicroscope with a magnification of (20 x) to determine the mode of bond failure (Fig 3). The obtained values of shear bond strength and adhesive remnant index were tabulated and sent for statistical analysis.

Figure 1: Curing using customized zig

Figure 2: Testing SBS using universal testing machine

Figure 3: ARI INDEX using Stereomicroscope

Results:

The difference in shear bond strength was recorded and the mean and standard deviation were calculated for the groups. The mean value was 23.06MPa with SD of ± 1.83, 20.56MPa with S.D of ± 2.13, and 14.09 MPa with SD of ± 2.52, for the groups A1, A2, and A3 (stainless steel brackets-American Orthodontics, WI, Sheboygan) respectively while the confidence interval was 95% (Table 1). The P value was statistically significant for all 3 groups as the value was less than .001. Likewise, the mean values of 31.38 MPa with SD of ± 1.54, 28.29 MPa with SD of ± 1.36, and 24.46 MPa with SD of ± 2.03 were obtained for the groups B1, B2, and B3 (monocrystalline ceramic brackets-American Orthodontics, WI, Sheboygan) respectively. With a confidence interval of 95%, the p-value showed statistical significance as the value is less than .001 for all 3 groups(Table 2). Alper et al evaluated the site of bond failure, where a significant difference was recorded between groups (Table 3). The results obtained were tabulated and statistically analyzed by unpaired T-test, One Way ANOVA, and POST HOC test.

Table 1 : Comparission Of Shear Bond Strength At Varying Distances Within Group A

Distance	Sample size (N)	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum	P value
				Lower Bound	Upper Bound			
0mm (A1)	20	23.065500	1.8341884	22.207073	23.923927	18.6600	25.5500	0.001
5mm (A2)	20	20.568000	2.1312872	19.570527	21.565473	15.5500	22.7700	0.001
10mm (A3)	20	14.094000	2.5224349	12.913464	15.274536	10.1100	17.3300	0.001
Total	60	19.242500	4.3738505	18.112615	20.372385	10.1100	25.5500	0.001

Table 2 : Comparison Of Shear Bond Strength At Varying Distances Within Group B

Distances	Sample sixe (N)	Mean	Std. Deviation	95% Confidence Interval for Mean		Minimum	Maximum	P value
				Lower Bound	Upper Bound			
0mm (B1)	20	31.384500	1.5468286	30.660562	32.108438	27.4000	33.0400	.0001
5mm (B2)	20	28.296500	1.3659285	27.657226	28.935774	25.8200	29.8600	.0001
10mm (B3)	20	24.467500	2.0303691	23.517258	25.417742	19.8600	26.5000	.0001
Total	60	28.049500	3.2922999	27.199009	28.899991	19.8600	33.0400	.0001

Table 3: Adhesive Remnant Index

VALUE	CRITERIA	GP A1	GP A2	GP A3	GP B1	GP B2	GP B3
0	Entire adhesive is left on the bracket base	1	2	12	2	3	7
1	More than half of adhesive left on bracket base	4	12	4	3	11	9
2	Less than half of adhesive left on bracket base	10	4	3	11	2	3
3	No adhesive is left on the bracket base	5	2	1	4	4	1

Discussion :

When the mean value of group A1 and B1 were compared , the values exhibited by B1 was far superior(31.38MPa), than values of group A1 which is (23.06MPa). this indicates high shear bond strength in group B1. The factor contributing for increase in shear bond strength maybe due to the increase in the transparency of the bracket which would have helped the curing light pass through the bracket and would have assisted in increase curing surface area.[5-8]

But according to the study done by **Javad et al in 2016 JDT**[9] , the bond strength of metallic bracket was superior to that of the ceramic brackets which was contradictory to the result obtained in our study. This maybe due to the thermocycling process which was done in their study.

On comparing the mean values of group A2 and B2 , group B2 exhibited superior bond strength of 28.29MPa than group A2 which was only 20.56Mpa. This suggest that the bond strength in group B2 is superior. Transparency of the ceramic brackets , plays a major role in increasing the bond strength by increasing the light penetration and curing depth .Though the distance of light source is increased by 5 mm in group A2 and B2 , the shear bond strength obtained was clinically accepted in both the groups and this maybe due to the high intensity of the light cure used which was 1200mW. [6,8,10,11]

On comparing group A3 and B3 , group A3 showed mean value of 14.09MPa and group B3 showed mean value of 24.46MPa , which suggest group B3 has increased bond strength compared to group A3 and this is due to the transparency of the bracket as discussed earlier.[(9,12,15,16)] But in a study done by **Gronberg et al in 2006 AO**[12)]the shear bond strength showed no significant difference at 0mm to 10mm distances, where the result of this study was in contradiction to the result we obtained in our study.

Thereby on comparing the shear bond strength within group A, the mean value of group A1 was 23.06MPa , group A2 was 20.56MPa and for group A3 it was 14.09 MPa. Therefore on comparing the mean values of all 3 groups, group A1 has higher shear bond strength than the other 2 groups .The overall mean value of group A was 19.24MPa.[(6,7,9)]

On comparing the mean value of group A1 and group A2 that is 23.06MPa and 20.56MPa respectively , it showed 11.46% of reduction in shear bond strength and on comparing group A1 with the mean value of group A3 which is 14.09MPa , reduction of 48.29% was observed . Similarly on comparing group A2 and group A3 there is 37.34% reduction of bond strength in the A3 group. This drastic reduction in the bond strength can be due to reduced light penetration as the metal brackets are opaque and also as the distance increases the intensity of the light decreases .[(6,7,9)]

Taking group B into consideration and on comparing the mean values between the group , group B1 showed mean value of 31.38MPa , and group B2 and B3 showed mean value of 28.29MPa and 24.46MPa respectively. Therefore on comparing within the groups, group B1 showed increased bond strength compared to group B2 and group B3. The overall mean value for group B was 28.04MPa .[(9,14,17,18)].

Comparing groups B1 and B2 which showed mean value of 31.38MPa and 28.29 MPa respectively , there showed 10.35% of reduction in bond strength in group B2 and similarly on comparing group B1 with group B3 , it showed 24.78% of total reduction in bond strength. On comparing group B2 to group B3 it showed 14.52% of reduction in bond strength. This reduction in bond strength is comparatively less in group B compared to that in group A due to the transparency of the bracket and the depth of light penetration.[(14-17)]

After debonding brackets, the base of the bracket was analyzed using stereomicroscope with 20x magnification[(19)]and the scores were noted as suggested by **A.Alper OZ** [(10)]**.**ARI is used to evaluate the amount of adhesive left on the bracket surface after debonding for assessing the site of bond failure.

On assessing ARI for group A1 there was increase in bonding between enamel adhesive interface rather than adhesive bracket interface.[(16)] Likewise for group A2 there was increase in bonding

between the bracket adhesive interface.[9]for group A3, there was less bonding between the adhesive enamel interface and more bonding between the bracket adhesive interface.[8]
Similarly on assessing ARI for group B1, it showed increased bond between the enamel and adhesive interface. [16,20] likewise for group B2 there was increase bond at bracket adhesive interface.[21,17] and for Group there was increase bond between the bracket adhesive interface. The decrease in bond strength between the groups is due to the increase in light tip distance to the bracket. [21]

Bonding the brackets is the first step done clinically in treating the orthodontic patients and debonding is the last treatment step done after the completion of orthodontic treatment before the retention protocol. So bonding is given the utmost importance as it influences the treatment outcome. Due to this reason, we have evaluated the shear bond strength depending on the distance of light curing for metal bracket and ceramic bracket. The metal bracket consistently exhibited less shear bond strength when subjected to light curing at various distances. But ceramic bracket Radiance plus which is a monocrystalline bracket exhibited high shear bond strength at all distances when subjected to light curing suggesting the transparent nature of monocrystalline bracket which directly is proportional to the translucency, which helps the curing light to pass through the surface of the bracket. With the results achieved in this study, we would like to suggest to cure the bracket at 0 mm for bonding as high shear bond strength was noticed at 0mm.

At 0mm distance of light curing, both stainless steel brackets and radiance plus brackets exhibited bonding at enamel adhesive interface. When both these brackets were light cured at 5mm and 10mm distance the bonding interface was seen at the adhesive bracket junction. This may be due to the lack of penetration of curing light through the adhesive as the curing light was placed further away

Conclusion:

1. Shear bond strength of stainless steel brackets when curing was done placing the light cure at various distances exhibited reasonable bond strength which meets the clinical standard suggested for shear bond strength , but the shear bond strength was less when the curing light was moved further away from the bracket surface, that is the more the distance from the curing light to the bracket surface the less the bond strength.
2. Radiance Plus brackets exhibited high shear bond strength values at all the distances, but the pattern was similar as the distance of the curing light to the bracket base increased. The shear bond strength was decreased.
3. When the shear bond strength was compared between the stainless steel bracket and the Radiance Plus bracket, the Radiance Plus brackets showed superior bond strength values. This might be due to the transparent nature of the bracket , which allows the curing light to pass through the bracket surface
4. Increasing the distance of the curing tip reduces the risk of cross contamination
5. Adhesive remnant index evaluation for the stainless brackets at 0mm distance exhibited bond interface between enamel adhesive interface, and at 5mm and 10mm distances the bond interface was observed between the bracket and the adhesive interface. When the Adhesive Remnant Index is evaluated in the Radiance Plus brackets surface at 0 mm, the bond interface was between the enamel and adhesive interface and the bond interface was between the adhesive and the bracket interface at 5mm and 10 mm distances. This might be due to the transparent nature of the bracket leading to the passage of the curing light through the bracket and assisting in excessive bonding between bracket adhesive interface.

Refrences :

1. Buanocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. J Dent Res 1955; 34: 849-853
2. Ramya Raghu. Clinical and Operative Dentistry- Principals and Practice, 2nd edition.329-34
3. Light LEDC. Elipar. :19–20: 3M UNITEK
4. Khadijah A. Turkistani, Precautions and recommendations for orthodontic settings during the COVID-19 outbreak: A review, AJODO, 2020 158(2):175-181
5. Cacciafesta V, Sfondrini MF, Scribante A, Boehme A, Jost-Brinkmann PG. Effect of light-tip distance on the shear bond strengths of composite resin. Angle Orthod. 2005;75(3):386–91.
6. Amit Jain et al. Light Cure Tip Distance and Shear Bond Strength : Does It have any Clinical Significance ? :JIOH 2013;47(September):135–42
7. Alper OZ et al. Assessment of the Confidence of the Adhesive Remnant Index Score With Different Methods. Turkish J Orthod. 2013;26(July 2013):149–53.
8. Ygreddy et al. The Shear Bond Strength Of Metal And Ceramic Brackets: An InvitroComparitive Study. JCDR:2013,July vol (7)1496-1497
9. Calipa.J et al. Comparison of bond strength of metal and ceramic brackets bonded with conventional and high-power LED light curing units.JDT, 2016;vol (13), no 6.
10. Joseph VP, Rossouw E. The shear bond strengths of stainless steel and ceramic brackets used with chemically and light-activated composite resins. AM J ORTHOD DENTOFAC ORTHOP 1990;97:121-5
11. Gwinnett.A.J. A comparison of shear bond strengths of metal and ceramic brackets. AJODO:1988,98:346-8.
12. Gronberg K, Rossouw PE, Miller BH, Buschang P. Distance and time effect on shear bond strength of brackets cured with a second-generation light-emitting diode unit. Angle Orthod [Internet]. 2006;76(4):682–8
13. Keuntaeketal.A stainless steel bracket for orthodontic application. .EJO 2005;235-237
14. Sfondrini MF, Cacciafesta V, Scribante A, Boehme A, Jost-Brinkmann PG. Effect of light-tip distance on the shear bond strengths of resin-modified glass ionomer cured with high-intensity halogen, light-emitting diode, and plasma arc lights. Am J Orthod Dentofac Orthop. 2006;129(4):541–6.
15. Chaconas, Angelo and Gary. Bond strength of ceramic brackets with various bonding systems. Angle Orthod 1990;61:35-42
16. Cornelia Speer, DorotheeZimny, Werner Hopfenmueller and Eva Andrea Holtgrave. Bond Strength of Disinfected Metal and Ceramic Brackets: An In Vitro Study. Angle Orthod 2005;75:836–842
17. Odeegard.J et al. Shear Bond Strength Of Metal Brackets Compared With A New Ceramic Bracket: AJODO,1988:94:201-6
18. Mohamed JP, Babu P, Kumar MS. Evaluating the Type of Light Transmittance in Mono Crystalline, Poly Crystalline and Sapphire Brackets- An Invitro Spectrofluorometer Study. 2016;10(8):18–21
19. Gupta.AS, Gautam R, Kalia A. Evaluation of different brands of LED curing devices for bonding metallic orthodontic brackets. Dentistry, 2014;4:9
20. Garma NMH, Sc M. The effect of light intensity and curing time of light emitting diode on shear bond strength using different types of bracket â€s materials. 2012;24(4):132–8
21. Eliades T, Viazis AD, Eliades G, Prairie E. Bonding of ceramic brackets to enamel: Morphologic and STM cultural considerations. 1991;369–75
22. Bordeaux JM, Moore RN, Bagby MD. Comparative evaluation of ceramic bracket base designs. 2000;552–60