ORIGINAL ARTICLE

Shear Bond Strength of Orthodontic Brackets Bond with Conventional Light Emitting Diode and Fast Halogen Light

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ABSTRACT

Aim: To compare the mean shear bond strength (MSBS) of metal brackets bonded with conventional LED or fast halogen units.

Methods: This in-vitro comparative study was conducted on 50 extracted human premolars which were randomly divided into 2 groups of 25 teeth each, by lottery method. Following a standard bonding protocol, Group 1, teeth brackets were cured with conventional LED light source and in group 2, by fast halogen light. MSBS was measured using universal testing machine, at a crosshead speed of 1 mm/minute and recorded in megapascals (MPa). Independent t-test was used for comparison of MSBS in both the groups. The level of significance was determined at $p \leq 0.05$. Duration of this study was January 2017 to October 2017.

Results: MSBS of metal brackets cured with fast halogen (17.60±3.7 MPa) was similar to conventional LED unit (16.66±3.0 MPa).

Conclusion: Fast halogens are equally effective for curing brackets, as they give similar bond strength when compared with conventional LED lights.

Keywords: Shear bond strength; LED; Halogen.

INTRODUCTION

Light cure composites for orthodontic bonding have been used for many years and got many advantages over self cure composite. Advantages include controlled working time, no need of mixing two pastes, allow accurate bracket positioning, less risk of cross infection, and easy removal of excess composite[1,2].

Conventional and fast set halogen light, plasma arc light, argon laser and light emitting diodes (LED) are available light source units[3]. Light curing units was introduced in 1980s. These light units have a wide wavelength range between 400 and 520 nm that while polymerization of composite resins triggers photo-initiators present in composites[4].

Halogen units produce light by heating tungsten filament, but got disadvantages of light power output, noisy fan, short lifetime of 100 hours and only 1% of the total energy input is converted into light; the remainder is wasted as heat[5]. In 1995, Mills introduced LED units for the polymerization of light composites, LED use junctions of doped semiconductors to produce light and got advantages of low power, 10000 hours life, smaller size, and resistant to shock and vibration[6].

According to literature, bonded brackets must have shear bond strength between 6 and 8 MPa[7,8,9] in order to achieve successful bonding. Results from previous literature[10] revealed that brackets cured with soft mode LED produced highest MSBS (23.86±6.20 MPa) but no significant difference in MSBS was found between fast mode LED (17.14±5.75 MPa) and the halogen group (17.38±5.41 MPa). Previous studies[11-13] also suggested that soft LED produce higher MSBS than the fast mode LED or halogen-light polymerizations. Rationale of present research was to compare the MSBS values in order to choose the better curing light. Data is publishing in this regard but results may be different in present study because previously conducted in-vitro studies were on LED and conventional halogen while in present study fast halogens were compared with LED units in reference to MSBS.

The aim of this study was to compare, in-vitro, the mean shear bond strength of metal brackets cured with fast halogen or conventional LED units. Our null hypothesis was that there was no difference in the MSBS of brackets cured with fast halogen or conventional LED units.

MATERIAL AND METHODS

This invitro comparative study. Was conducted at Faisalabad Medical University and de'Montmorency College of Dentistry Lahore. Duration of this study was January 2017 to October 2017. Sample size of 50 was estimated using 95% confidence level, 80% power of test with expected mean shear bond

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strength 17.38±5.41 MPa in halogen group and 17.14±5.75 MPa in LED group[10]. Non-probability purposive sampling technique was used.
Maxillary/Mandibular bicuspids and intact buccal surface were included in the study. While any dental pathology involving buccal surface with history of orthodontic treatment were excluded from the study.

According to selection criteria, 50 extracted human premolars were included and were kept in 0.1% thymol solution. The teeth were embedded perpendicularly in self cure acrylic moulds and polished with pumice. Teeth were randomly allocated into 2 groups by using lottery method. Group A, 25 teeth were cured with Conventional LED unit (1000 mW/cm^2) and in group B, 25 teeth were cured with fast halogen unit (1100 mW/cm^2). Each curing light was tested and calibrated according to the manufacturer's recommendations to ensure that maximum intensity output was obtained. The distance of light curing tip was kept at minimum in both the groups i.e., 2mm. The brackets cured with the fast halogen had curing times of 5 seconds each on the mesial and distal sides; the brackets cured with the LED had curing times of 10 seconds each on the mesial and distal sides.

The teeth were initially cleansed and polished. Each tooth was etched with 37% phosphoric acid gel for 30 seconds followed by rinsing and air drying. Transbond XT primer (3M-Unitek) was applied; air thinned and light cured. Premolar brackets with a bracket base area of 11.35 mm^2 (3M-Unitek) were taken and bonded to the buccal surface using Transbond XT adhesive paste (3M Unitek). Samples were stored in distilled water for 24 hours and thermocycled.

The bonded teeth were then tested on universal testing machine at 0.5mm/min. The MSBS was measured in Newton's and then converted in MPa using the formula: Shear strength (MPa) = Debonding force (N)/bracket base area (mm^2) and 1 N/mm[14].

Data collected was analyzed by using SPSS version 20.0. The MSBS was presented in the form of mean, standard deviation and t-test was applied for comparison of MSBS between the two groups and level of significance was determined at p≤0.05.

RESULTS

The mean and standard deviation values for the MSBS of two groups are presented in the table I and II. The t-test comparison indicates that there is insignificant difference between the two groups. The fast halogen group has similar MSBS when compared with conventional LED group (Table III)

Table 1: Mean Shear bond strength of LED group

n	Mean	Std	Std error mean
25	16.644	3.0076	1.0371

Table 2: Shear bond strength of fast halogen group

n	Mean	Std	Std error mean
25	16.644	3.7009	1.6786

Table 3: Comparison of 2 groups (Shear bond strength (MPa)

T Test				95% Confidence interval of the Difference	
T	Sig.(2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
0.977	0.150	1.0411	0.7866	0.0345	2.9900

DISCUSSION

To increase the polymerization efficiency and because of the demand of orthodontists to bond speedily, manufacturers developed light units with increased intensities. Curing orthodontic adhesives with plasma arc source of 1500 mW cm^2 intensity produce optimal cure in 3–5 seconds.[15] Recently, high-intensity fast halogen lamps have been developed that got 1000 mW cm^2 intensity, resulting in curing times of around 10 seconds[16].

This in-vitro comparative study was conducted to determine the mean shear bond strength of brackets cured with conventional LED or fast halogen units. According to results statistically there was insignificant difference between the two groups, with MSBS of fast halogen group as 17.60±3.7 MPa whereas the MSBS of conventional LED group was 16.66±3.0 MPa. This could have happened because of equal polymerization by high intensity fast halogens[16] and LED lights and may also be due to the fact that fast halogen has light energy, luminous intensity, and spectral distribution similar to LED. It is possible that these results reflect the use of powerful halogens as compared to first-generation LED units[17].

Results are in agreement with previous laboratory studies on the bond strength of brackets cured with LED that reported no statistically significant differences in MSBS between conventional halogen and LED light[18,19,20]. However, previously conducted studies were conducted to compare LED and conventional halogens. There are certain differences in conventional and fast halogens, such as fast halogens got high intensity values than conventional LED[16].

Results are in agreement with Cacciafesta who compared new model of LED with halogen, and found no significant difference in MSBS[21]. Similarly, in a study by Usumez, no significant differences were observed in MSBS between halogen and LED units, at various times of curing[22]. Bishara reported that in the first 30 minutes after bonding, LED and halogen produced similar MSBS[23]. Thind showed that there was no difference between the adhesive remnant scores produced by the conventional tungsten-quartz-halogen and LED light sources[24]. Our results are in contrast with results reported by Wendle who showed that halogen yields stronger MSBS than does LED[25].

In this study, we did not evaluate the temperature changes with two curing lights. According to Ramoglu[26], the most powerful LED unit having intensity of 3200mW/cm^2 caused the minimal rise in temperature in comparison to other low intensity LEDs, and that too within the safe range for teeth pulp.

Caution should be exercised when applying the results of this in-vitro study, because it was a laboratory study and could have the limitations of an ex-vivo setup. Despite this limitation, the result of the current study suggests that LED or fast halogen units, can be choose for bonding orthodontic brackets without any compromise in the shear bond strength of orthodontic brackets.

CONCLUSION

Fast halogen lights are equally effective for curing orthodontic brackets as they give similar bond strength as compared with conventional LED lights.

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REFERENCES

1. Khan AS, Azam MT, Khan M, Mian SA, Rehman IU. An update on glass fiber dental restorative composites: a systematic review. Materials Science and Engineering: C. 2015 Feb 1;47:26-39.
2. Kloukos D, Pandis N, Eliades T. Bisphenol-A and residual monomer leaching from orthodontic adhesive resins and polycarbonate brackets: a systematic review. American journal of orthodontics and dentofacial orthopedics. 2013 Apr 30;143(4):S104-12.
3. Fleming PS, Eliades T, Katsaros C, Pandis N. Curing lights for orthodontic bonding: a systematic review and meta-analysis. American journal of orthodontics and dentofacial orthopedics. 2013 Apr 30;143(4):S92-103.
4. Ward JD, Wolf BJ, Leite LP, Zhou J. Clinical effect of reducing curing times with high-intensity LED lights. The Angle orthodontist. 2015 Mar 11;85(6):1064-9.
5. Price RB, Shortall AC, Palin WM. Contemporary issues in light curing. Operative dentistry. 2014 Jan;39(1):4-14.
6. Jandt KD. A brief history of LED photopolymerization. Dental Materials. 2013 Jun 30;29(6): 605-17.
7. Abushawashi N, Vimonsatit V. Material Classification and Composite Elastic Modulus of Hybrid PVA Fiber Ferrocement. Journal of Materials in Civil Engineering. 2016 Mar 29;28(9):04016073.
8. Fleming PS, Eliades T, Katsaros C, Pandis N. Curing lights for orthodontic bonding: a systematic review and meta-analysis. American journal of orthodontics and dentofacial orthopedics. 2013 Apr 30;143(4):S92-103.
9. Amato PA, Martins RP, dos Santos Cruz CA, Capella MV, Martins LP. Time reduction of light curing: Influence on conversion degree and microhardness of orthodontic composites. American Journal of Orthodontics and Dentofacial Orthopedics. 2014 Jul 31;146(1):40-6.
10. Türkkahraman H, Küçükeşmen HC. Orthodontic bracket shear bond strengths produced by two high-power light-emitting diode modes and halogen light. The Angle Orthodontist. 2005 Sep;75(5):854-7.
11. Krishnaswamy NR, Sunitha C. Light-emitting diode vs halogen light curing of orthodontic brackets: a 15-month clinical study of bond failures. American Journal of Orthodontics and Dentofacial Orthopedics. 2007 Oct 31;132(4):518-23.
12. 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. American journal of orthodontics and dentofacial orthopedics. 2006 Apr 30;129(4):541-6.
13. Staudt CB, Mavropoulos A, Bouillaguet S, Kiliaridis S, Krejci I. Light-curing time reduction with a new high-power halogen lamp. American Journal of Orthodontics and Dentofacial Orthopedics. 2005 Dec 31;128(6):749-54.
14. Gheath HY, Jaffery PA, Andreason TH. Bovine teeth as substitute for human teeth in dental research: a review of literature. J oral scien. 2011;53(3):27.
15. Lamper T, Ilie N, Huth KC, Rudzki I, Wichelhaus A, Paschos E. Self-etch adhesives for the bonding of orthodontic brackets: faster, stronger, safer?. Clinical oral investigations. 2014 Jan 1;18(1):313-9.
16. Talic NF. Failure Rates of Orthodontic Fixed Lingual Retainers bonded with Two Flowable Light-cured Adhesives: A Comparative Prospective Clinical Trial. The journal of contemporary dental practice. 2016 Aug 1;17(8):630-4.
17. Caughman W. Shedding new light on composite polymerization. Operative dentistry. 2001;27(6): 636-8.
18. Üsümez S, Büyükyilmaz T, Karaman A. Effect of light-emitting diode on bond strength of orthodontic brackets. The Angle orthodontist. 2004;74(2):259-63.
19. Bishara SE, Ajlouni R, Oonsombat C. Evaluation of a new curing light on the shear bond strength of orthodontic brackets. The Angle orthodontist. 2003;73(4):431-5.
20. Cacciafesta V, Sfondrini MF, Jost-Brinkmann P-G, Boehme A. Light-emitting diode technology for orthodontic bonding. Journal of clinical orthodontics: JCO. 2002;36(8):461.
21. Carvalho FD, Almeida RC, Almeida MA, Cevidanes LH, Leite MC. Efficiency of light-emitting diode and halogen units in reducing residual monomers. American Journal of Orthodontics and Dentofacial Orthopedics. 2010 Nov 30;138(5):617-22.
22. Usmez S, Ihayakaraman A, Ilamaz TB. Effect of LED on bond strength of orthodontic brackets. J Angle Orthod. 2004;74(2):252-63.
23. Bishara SE, Ajlouni R, Oonsombat C. Evaluation of a new curing light on the shear bond strength of orthodontic brackets. The Angle orthodontist. 2003;73(4):431-5.
24. Thind BS, Stirrups DR, Lloyd CH. A comparison of tungsten-quartz-halogen, plasma arc and light-emitting diode light sources for the polymerization of an orthodontic adhesive. The European Journal of Orthodontics. 2006;28(1):78-82.
25. Wendl B, Droschl H. A comparative in vitro study of the strength of directly bonded brackets using different curing techniques. The European Journal of Orthodontics. 2004;26(5):535-44.
26. Ramoglu SI, Karamehmetoglu H, Sari T, Usumez S. Temperature rise caused in the pulp chamber under simulated intrapulpal microcirculation with different light-curing modes. The Angle Orthodontist. 2015 May;85(3):38