ISSN (O) : 2582-3271
PubMed-National Library of Medicine - ID: 101766917

International Journal of Dental Science and Clinical Research (IJDSCR)

Dr. Angel Vaidic Publication

Available Online at: http://www.ijdscr.org

Volume 3, Issue 4, August - 2021, Page No. : 21 - 29

A Comparative Study of the Shear Bond Strengths of Two Orthodontic Adhesive Systems in a Nigerian Population

[1]Okeke AC, Department of Child Dental Health, University of Nigeria, Enugu, Nigeria

[2]Utomi IL, Department of Child Dental Health, University of Lagos, Nigeria

[3]Folaranmi N, Department of Child Dental Health, University of Nigeria, Enugu, Nigeria

Citation of this Article: Okeke AC, Utomi IL, Folaranmi N, "A Study of Association of Level of Thyroid Hormone with Non-Alcoholic Fatty Liver Disease,'' IJDSCR – August – 2021, Vol. – 3, Issue - 4, P. No. 21-29.

Corresponding Author: Okeke AC, Department of Child Dental Health, University of Nigeria, Enugu, Nigeria

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Introduction

The duration of orthodontic treatment varies depending on different factors. In contemporary orthodontic therapy, brackets are bonded to tooth surfaces by using orthodontic adhesives. These adhesives are expected to have reasonable bond strengths because inadequate bond strength leads to bracket failure, as the brackets are detached from the teeth, therefore prolonging the entire treatment duration.

Objectives

Tocompare the shear bond strengths of Light Bond(R) light-cure and Rely.a.Bond(R) self-cure adhesives when used to bond orthodontic brackets.

Materials and Methods

It was a cross-sectional study in which brackets were bonded to teeth gotten from intending orthodontic patients in whom extraction was a part of their treatment plan using the light cure and the self cure adhesives. Shear bond strengths determination was carried out in the laboratory of the Standards Organisation of Nigeria, to determine shear bond strengths of Light Bond(R) light-cure and Rely.a.Bond(R) self-cure adhesives used in bonding brackets to the extracted teeth. 88 brackets were bonded to 88 teeth. Each of the two adhesive types was used to bond forty-four (44) of the brackets. Teeth were bonded following a standardized procedure. Data were analysed using frequency, percentage, mean statistics and t-test. A p-value of 0.05 or less was considered statistically significant. Statistical Package of Social Science version 21.0 was used to analyse the data generated.

Results

The mean shear bond strength of Light Bond(R) light-cure was 10.58MPa while that of the Rely.a.Bond(R) self-cure adhesive system was 7.40MP. This greater shear bond strength of the Light Bond(R) was statistically significant (p-value=0.001).

Conclusion

The mean shear bond strength of the light-cure (Light Bond(R))adhesive was significantly higher than that of the self-cure.

Keywords

Shear, Bond, Strength, Adhesive

Introduction

Orthodontic brackets are important attachment components of fixed orthodontic appliances. They act as both channel and source of delivering force from the archwire to the teeth.[1]Someyears ago, bands to whichorthodontic brackets were soldered was in common use in a technique called, "full mouth banding"[2,3]The technique was unaesthetic, irritated soft tissues, caused pain and was associated with a significant increase in the chair side time.[2,3]In 1955, the "full banding technique" was replaced by the "acid etch techinique".[4]In this technique, Buonocore used 85% Phosphoric acid on enamel surface for 80 seconds to create micropores, thus allowing direct bonding of brackets to the teeth using adhesives.[3,5] However, the major challenge with the use of the acid etch technique is bracket failure, which is said to have occurred when the adhesives no longer holds the brackets onto the teeth in the course of orthodontic treatment.[6]Bracket failures are relatively frequent, and have many undesirable consequences, including an increase in decalcification, overall cost and treatment time.[7,8,9] Therefore, the success of these adhesives in fixed appliance therapy largely depends on their capability to resist failure from a large number of forces directed to bracket-adhesive-enamel junction as well as various factors in the mouth.[10] An orthodontic adhesive should be capable of enabling bracket to stay bonded to the enamel for the whole duration of treatment while also permitting easy removal of brackets when need arises without damage to enamel surface and with least discomfort to the patient.[11]Despite significant advancements in adhesive science, including the invention of the self-cure, the light-cure and the dual-cure adhesives, bracket failures continue to be a challenge.[5] An important factor that may predispose to bracket failure is inadequate shear bond strength of the orthodontic adhesive. The shear bond strength is described as the peak force required to cause detachment of the bracket from the tooth using a shear force divided by the contact area between the bracket and the tooth.[10,12] An optimal bond strength of 6 – 8 MPa[13,14]is, therefore, necessary for every orthodontic adhesive.[15] Shear bond strength is best accessed by in-vitro studies in which controlled testing environment for investigating chemical and physical properties of adhesives is possible. Information provided on the amount of controlled force that is responsible for failure in bracket-adhesive-enamel is useful for clinical practice and in vivo investigations.[16] To ensure that the chemical nature of adhesives remain intact, most manufacturers recommend storing adhesives in the refrigerator and preheating to body temperature before use.[17]There is a dearth of literature on the shear bond strength of orthodontic adhesives in tropical Africa, where the climate is relatively hot and electric power supply irregular in most parts. The present in-vitro study carried out in Nigeria, compared the shear bond strengths of Light Bond(R) light-cure and Rely.a. Bond(R) self-cure adhesives to determine the adhesive with a

better shear bond. The findings will, therefore, aid clinicians in making the right choice of adhesives across different regions of the world.

Materials and Methods

The study was carried out at the laboratory of the Standards Organization of Nigeria (S.O.N) in Enugu after ethical approval was obtained from the Ethics and Research Committee of the University of Nigeria Teaching Hospital (UNTH), Enugu.It was a cross-sectional study in which the shear bond strengths of light Bond(R) light-cure and Rely.a.Bond(R) self-cure adhesives were determined in the laboratory. These adhesives were used to bond 88 brackets on 88 teeth extracted from 28 consecutive patients (needing extraction as part of their orthodontic treatment plan) who presented at the orthodontic clinic of the UNTH.Microdonts, teeth with enamel hypoplasia and fracture or restorations on their buccal surfaces were excluded from the study.

Consecutive teeth which met the inclusion criteria and extracted from male and female participants. The minimum number of teeth, "n", was equal to 42. This was the minimum number of teeth which was necessary for bonding brackets using each group of adhesives. However, forty-four (44) teeth were bonded for each adhesive type, exceeding the minimum sample size by two teeth per adhesive system because two further extracted teeth were included per adhesive type. Thus, extracted teeth were consecutively included in determining the shear bond strength of adhesives until a total of eighty-eight teeth was reached.

In the determination of shear bond strength of the light-cure (Light Bond(R)) and the Self-cure (Rely.a.Bond(R)) composite adhesive systems, each of the eighty-eight extracted teeth was put into a container which contained 10% formalin. Immediately after extraction, the containers were labelled from numbers 1-88, according to the sequence of extraction, and each tooth was left in the formalin for 7 days as was done in a similar study.[18]Irrespective of the tooth type, the first tooth extracted was numbered as "1", the next as "2" and progressing in that pattern until the 88th tooth was extracted. The extracted teeth were also divided into group "A" and group "B" sets of teeth. The group A (with "Red" colour coded container) were the teeth labelled with odd numbers. Orthodontic brackets were bonded on them using the self-cure adhesive. The group B (with "Blue" colour coded container) were those labelled with even numbers. Brackets were bonded onto these teeth using the light-cure adhesive. Forty-four brackets were bonded using each adhesive type. The detailed steps followed in the study are highlighted below:

The tooth was brought out of the formalin in which it had been stored for 7 days, rinsed in water and dried with a stream of air.In order of extraction, each tooth was separately mounted on a cold cure acrylic block (up to the neck of the tooth) (Figure 1). The tooth was scaled using manual scalers and subsequently polished using a fluoride and an oil free prophylactic paste. They were then washed with water and dried in a stream of oil-free compressed air.[18]A bracket was then bonded on the buccal surface of each tooth before taking it (singly or in groups of teeth extracted the same day) to the laboratory for shear bond strength testing, which was done 24 hours after bonding, as reported for previous studies.[10,19]

The self-cure adhesive, stored according to the manufacturer's recommendation was used to bond brackets on the 44 teeth in Group "A as follows:A brush applicator, was used to apply 37% Phosphoric acid gel to the mid-buccal enamel surface of each tooth

from Group "A" and left for 15 seconds (as recommended by the manufacturer and has been reported as the optimal time for etching.[20]) The tooth was rinsed with water and dried with oil free compressed air, until the enamel surface became frosty white. The primer was applied onto the etched tooth surface and the mesh surface of the bracket. The self-cure adhesive was syringed onto the bracket base (just enough to cover the bracket base when placed on the tooth).

The bracket was firmly placed in position on the buccal tooth surface. Thirty seconds was allowed for the bonded bracket to become reasonably stable before excess adhesive was removed using a sharp probe.[18] A minimum waiting period of 10 minutes was observed to allow for adequate polymerization of the adhesive.[21,22]A total of 44 teeth were bonded in the study using the self-cure adhesive.

For the Bonding with the light-cure (Light Bond(R)) Adhesive, a brush applicator was used to apply 37% Phosphoric acid gel to the mid-buccal enamel surface of teeth from the Group "B" and left for 15 seconds (as recommended by the manufacturer). The tooth was rinsed with water and dried in a stream of oil-free compressed air until the enamel became frosty white.[18] A thin layer of primer was applied on the etched teeth surface with a different brush applicator. The Light-cured bracket adhesive was syringed onto the bracket base and placed in position on the buccal tooth surface. Excess resin was removed by running a dental probe around the base of the individual brackets. The resin was polymerized by pointing a LED light source with wavelength of 480nm on the tooth (20 seconds for each bracket-adhesive interface: 10 seconds on the mesial and 10 seconds on the distal) and polymerization occurred immediately.[22]A total of 44 teeth were bonded (singly or in groups of teeth extracted the same day) in the study using the light-cure adhesive. Each tooth was carried to the laboratory on the acrylic block for Shear Bond Strength Testing.

To determine the shear bond strength, the teeth on the acrylic blocks were taken to the laboratory. To determine the shear bond strength, de-bonding of the bracket from the teeth was carried out after 24 hours (as was done in previous studies.[10,19]), one tooth at a time using the Universal Testing Machine, as was carried out in previous studies.[21,22,23,24]To facilitate the application of a vertical debonding force, the tooth surface was positioned perpendicular to the horizontal plane. An occluso-gingival load was applied to produce a shear force at the bracket-tooth interface. (This was accomplished with the flattened end of a steel rod attached to the crosshead of the universal testing machine.[23])The bond strengths were determined at a crosshead speed of 1mm per minute, and the force applied at the time of fracture/de-bonding (the critical point at which de-bonding occurred) was recorded in Newtonsand then divided by the area of the bracket base (which is 12.1mm^2) to convert to megapascals (MPa).[12]

While recording data, the following were noted:

a. The type of adhesive used per tooth
b. The shear bond strength for groups A and B (those bonded with the self-cure adhesive and the light-cure, respectively).

Statistical analysis

Analysis of the data was carried out using descriptive statistics (frequency, percentage, mean and standard deviation). To determine the shear bond strength for each of the adhesives systems, mean statistics was used. The comparison of the shear bond strengths of the two adhesives was analysed using t-test.

A p-value of 0.05 or less was considered statistically significant. Statistical Package of Social Science (SPSS)/ Statistical Product for Service Solution (SPSS) version 21.0 was used to analyse the data generated.

Results

The sociodemographiccharacteristics of the study subjects as seen in table 1, shows that there were twenty eight patients whose ages ranged from 13-37 years with a mean age of 17.79 ± 6.20 years. The majority of participants (71.4%) were aged 13-17years of age. The participants were predominantly males (64.3%) and females (35.7%). Most of the teeth extracted and used in the study were First Premolars (97%), the remaining were 2nd Premolars as seen in Figure 2.

Table 2 reveals that the mean shear bond strength of (Light Bond(R))light-cure adhesive was 10.58MPa (ranging between 5 and 20.70) while the mean shear bond strength for (Rely.a.Bond(R))self-cure adhesive system was 7.40MPa, which ranged between 4.60 and 12.80 MPa. There was a statistically significant difference between mean shear bond strengths of light-cure and Self-cure (p =0.001).

Discussion

The results of the present study showed that most of the teeth extracted in the course of patient's treatment and used for the study were 1st Premolars (97%) while the remaining (3%) were 2nd Premolars. This is similar to what was reported in a previous study.[25] The mean shear bond strength of light-cure (Light Bond(R))adhesive was significantly higher than that the of self-cure (Rely.a.Bond(R)) adhesive system. The finding in this study validates that which was previously reported by Shukla et al,[26] who reported a higher mean shear bond strength of 10.34MPa for the light-cure and 9.03 MPa for the self-cure adhesive. Similarly, a later study[27] reported higher shear bond strength of 15.49MPa for the light-cure adhesive, while that for the self-cure adhesive was 12.26MPa. This however, differs from that reported in two similar studies[28,29]in which lower bond strength was reported for the light-cure adhesives, with both reporting the bond strength of the light-cure adhesives to be nearly half of the self-cure. Toledano et al[28] also reported a lower bond strength of 35.96MPa for the light-cure adhesive and 71.31MPa for the self-cure adhesive. This much lower bond strength of the light-cure adhesive was said to perhaps be because of incomplete polymerization[28,29,30].

However, bond strengths recorded for the light-cure (Light Bond(R)) and self-cure (Rely.a.Bond(R)) adhesive system recorded in the present study, show that both adhesive types meet the reported minimum clinically adequate shear bond strength of 5.8-7.8MPa reported in the literature[13]. Also, the values found in the present study are within the safe shear bond strength value, following the report that at bond strength of 12.75MPa or more, there is increase in the risk of enamel surface fracture during debonding[15,31].

Variables	Frequency (n=28)	Percentage	Mean
13-17	20	71.4	
18-22	4	14.3	17.79± 6.20
23-27	1	3.6	
28-32	2	7.1	
33-37	1	3.6	
Sex			
Male	18	64.3	
Female	10	35.7	

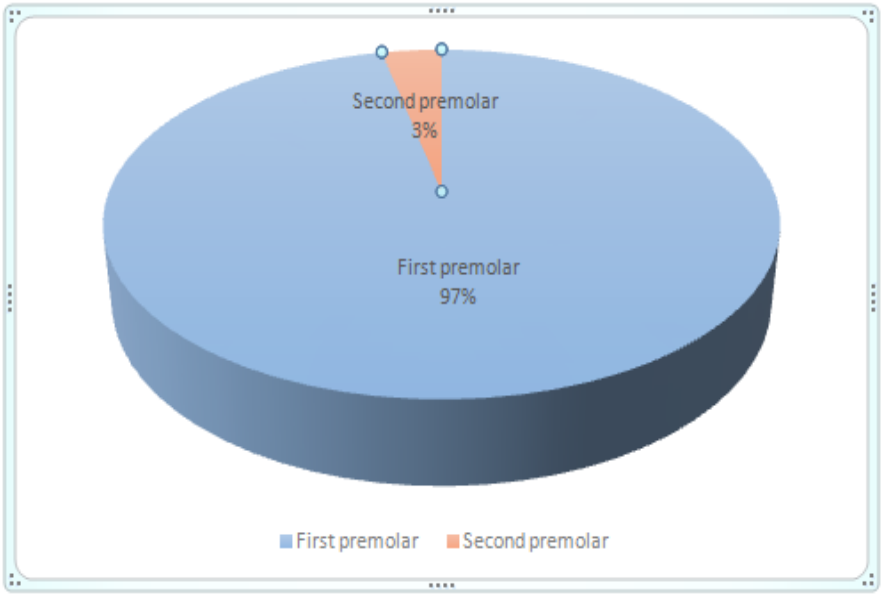
Table 1: Distribution of Participants Sociodemographic Characteristics

Variables	Adhesive type	Range		Mean	S.D.	t-value	p-Value (p<0.05)
		Minimum	Maximum				
Bond Strength	Light-cure	5.00	20.70	10.58	3.82	-3.559	0.001*
	Self-cure	4.60	12.80	7.40	2.29		

Table 2: Comparison of Mean Shear Bond strengths of light-cure and Self-cure Adhesives

Figure 1: Teeth mounted on Cold cure acrylic block (with bonded orthodontic brackets)

Figure 2: Percentage distribution of the type of teeth used in the Laboratory



Conclusion

The mean shear bond strength of light-cure (Light Bond(R))adhesive was significantly higher than that of the self-cure (Rely.a.Bond(R)) adhesive system.The Light Bond (R) Light-cure adhesive and the Rely.a.Bond Self-cure adhesive had acceptable laboratory shear bond strength.

Recommendations

The findings in this study show that though both the light-cure and self-cure adhesives have shear bond strengths which are clinically acceptable, the shear bond strength of the light-cure adhesives is significantly higher and should be preferred to the self-cure adhesive for clinical use.

References

1. Bherwani A, Fida M. Bond failure with a No-Mix Adhesive System. Angle Orthod. 2008; 78:545-548.
2. Kafle D, Agarwal A, Shrestha S, Adhikari B: Banding on Adolescents: Is Molar Band Height Different than Clinical Crown Height? Orthod J Nep. 2014; 2: 7-11.
3. Gange P. The evolution of bonding in orthodontics. Am J OrthodDentofacialOrthop. 2015;147: 56-63.
4. Zero DT. How the introduction of the acid-etch technique revolutionized dental practice.J Am Dent Assoc. 2013;9:990-994.
5. Zachrisson BU A post-treatment evaluation of direct bonding in orthodontics. Am J OrthodDentofacialOrthop. 1977; 71:173-189.
6. Reis A, Santos JE, Loguercio AD, Bauer JRO. Eighteen-month bracket survival rate: conventional versus self-etch adhesive. Eur J Orthod. 2008; 30:94-99.
7. Natheer AR. Orthodontic bracket failure rate; a comparative clinical study between light-cured and chemically cured (no mix) bonding systems. J BaghColl Dentistry 2012; 24:137-139.
8. Cook A. Curing lights–are you contributing to your bond failure rate? http://www.andreacook consulting.com/newsletter archives/2010 07/
9. Aljubouri YD, Millett DT, Gilmour WH. Six and 12 months' evaluation of a self-etching primer versus two-stage etch and prime for orthodontic bonding: a randomized clinical trial. Eur J Orthod. 2004: 26:565–571.

10. Markovic E, Glisic B, Scepan I, Markovic D, Jokanovic V. Bond strength of orthodontic adhesives. Metal J Metall 2011; 14:78-88.
11. Klocke A, Tadic D, Kahl-Nieke B, Epple M. An optimized synthetic substrate for orthodontic bond strength testing. Dent Mater. 2003;19:773-778
12. Abd SD, Al-Khatieeb, MM. Shear Bond Strength and Excess Adhesive Surface Topography of DifferentBonding Systems after Thermocycling: A Comparative In-vitro Study. Int. J. Med. Res. Health Sci. 2018; 7:46–54
13. Reynolds IR. A review of direct orthodontic bonding. Br J Orthod.1975; 2:171-178.
14. Hammad SM, El Banna MS. Effects of cyclic loading on the shear bond strength of metal orthodontic brackets bonded to resin composite veneer surface using different conditioning protocols. ProgOrthod. 2013;14:14.
15. Retief DH, Dreyer CJ, Gavron G. The direct bonding of orthodontic attachments to teeth by means of an epoxy resin adhesive. Am J Orthod 1970; 58:21-40.
16. Eliades T, Eliades G, Bradley TG, Watts DC. Degree of cure of orthodontic adhesives with various polymerization initiation modes. Eur J Orthod 2000: 22:395
17. Akarsu S, Buyuk SK, Kucukekenci AS. Effects of adhesive systems at different temperatures on the shear bond strength of orthodontic brackets. J Dent Res Dent Clin Dent Prospects. 2019;13:103-108.
18. Lolayekar NV, Bhat VS, Baht SS. Disinfection methods of extracted human teeth. J Oral Health Comm Dent. 2007; 1: 27-29
19. Bin Abdullah M, Rock WP. The effect of etch time and debond interval upon the shear bond strength of metallic orthodontic brackets. Br J Orthod. 1996; 23:121-124.
20. Parihar N, Pilania M. "SEM evaluation of effect of 37% phosphoric acid gel, 24% EDTA gel and 10% maleic acid gel on the enamel and dentin for 15 and 60 seconds: an in-vitro study." Int Dent J Stud Res. 2012; 1: 29–41.
21. Sonis AL. Comparison of a light-cured adhesive with an autopolymerization bonding system. J ClinOrthod. 1988; 22: 730-732.
22. Hamula DW. Technique clinic: Direct bonding with light-cured adhesives. J ClinOrthod 1991; 25: 437-438.
23. Rajagopal R, Padmanabhan S, Gnanamani J. A comparison of shear bond strength and de-bonding characteristics of conventional, moisture-insensitive and self-etching primers in vitro. Angle Orthod. 2004; 74:264–268.
24. Bayram M, Yeşilyurt C, Kuşgöz A, Ülker M, Nur M. Shear bond strength of orthodontic brackets to aged resin composite surfaces: effect of surface conditioning. Eur. J. Orthod. 2011; 33:174–179
25. Alhasyimi AA, Pudyani PS, Hafizi I. Effect of mangosteen peel extract as an antioxidant agent on the shear bond strength of orthodontic brackets bonded to bleached teeth. Dental Press J Orthod. 2018;23:58-64.
26. Shukla C, Singh G, Jain U, Swamy K. Comparison of mean Shear bond strength of Light-cure, Self-cure Composite Resins, Self-Etching and Moisture-insensitive Primers: An in vitro study. J Ind. Orthod Soc. 2012; 46:254-257.
27. Sharma S, Tendon P, Nagar A, Singh GP, Singh A, Chugh VK. A comparison of shear bond strength of orthodontic brackets bonded with four different orthodontic adhesives. J Orthod Sci. 2014; 3:29-33.

28. Toledano M, Osorio R, Osorio E, Romeo A, de la Higuera B, García-Godoy F. Bond strength of orthodontic brackets using different light and self-curing cements. AngleOrthod. 2003;73:56-63.
29. Omidkhoda M, Shahabi M, Fakharian M, Rangrazi A. Evaluation of the bond strength of light-cure and chemical-cure adhesive systems over time: an in-vivo study using a new force gauge. Mater. Res. Express 2019; 9:1-3
30. Verma G, Trehan M, Sharma S. Comparison of Shear Bond Strength and Estimation of Adhesive Remnant Index between Light-cure Composite and Dual-cure Composite: An in vitro Study. Int J ClintPediatr Dent. 2013; 6:166-170.
31. Ozcan M, Finnema K, Ybema A. Evaluation of failure characteristics and bond strength after ceramic and polycarbonate bracket debonding: effect of bracket base silanization. Eur J Orthod. 2008;30:176–182.