WEST AFRICAN JOURNAL OF ORTHODONTICS

Print ISSN: 2315-9634
E-ISSN: 3141-5822

VOLUME 12, NUMBER 1

JUNE 2023

Artificial Intelligence in Orthodontics

Knowledge and Practice of Oral Habits in Children

Orthodontic Bond Failure Rate using Light Cure Adhesive

Multidisciplinary Management of a Class III Malocclusion

The Spontaneous Correction of Anterior Crossbite

OFFICIAL PUBLICATION OF ORTHODONTIC ASSOCIATIONS IN THE WEST AFRICAN SUB-REGION
"DENTISTRY'S FIRST SPECIALTY JOURNAL IN SUB SAHARAN AFRICA"

Orthodontic Bond Failure Rate using Light Cure Adhesive in a Tertiary institution in North Central Nigeria.

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Abstract

Background: Orthodontic treatment involves many procedures including direct bonding of an orthodontic bracket to the tooth using a variety of techniques, including the acid etch technique. An orthodontic bracket bond failure is said to have occurred when the bracket attachment to the enamel surface of a tooth ceases to be attached by the adhesive bond.

The aims of this study were to determine the failure rate of Orthodontic brackets bonded using light-cure adhesive and to determine the effect of age and sex on bracket failure rate.

Methods: One hundred and one patients (101) made up of forty-one males and sixty females respectively (41 M, 60 F), with a mean age of 16.52 ± 8.32 years participated in the study, using an interviewer-administered questionnaire. A total of one thousand five hundred and twenty-six brackets were bonded by a single operator using light cure adhesive. Data was analyzed using frequency, percentage, mean statistics, t-test, correlation, and multiple linear regression analyses. A p-value of 0.05 or less was considered statistically significant.

Results: The orthodontic bond bracket failure rate was 10.2%. Age and sex were significant predictors of bracket failure rate (p-values of 0.001 and 0.013) respectively.

Conclusion: The bracket failure rate was similar to other studies. In this study, age and sex had a significant influence on the bracket failure rates of orthodontic brackets.

Keywords: Orthodontic bond, failure, light cure.

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ORIGINAL ARTICLE

Introduction

The first and most popular bonding resins introduced were the self-curing bonding Systems[1], which consisted of two-paste-mix self-curing polymeric resin adhesives, invented in the 1970s for direct bonding of attachments to etched enamel surface[2]. In 1975, the no-mix self-cure adhesive was invented, this eliminated the clumsiness of the mixing steps in the two-mix system[3]. The first single-paste ultraviolet light-curing adhesive was introduced in 1974, however, its use for orthodontic bonding was not first described until 1979[4]. The evolution of the light source has been from bulky, corded halogen curing lamps to lightweight, portable, light-emitting diodes (LED) lights.[5] Light-cure adhesives polymerize due to a reaction between the catalyst in the adhesive and the photon emitted by the light-curing source.

Orthodontic treatment involves the bonding of an orthodontic bracket to the tooth using a variety of techniques, including the acid etch technique. The bond should last till the end of treatment if all necessary factors are favourable. However, the major challenge of orthodontic bond failure is the negative impact of premature or unintentional debonding on the course of treatment[6]. In good clinical practice, orthodontic bond failure should not exceed 6%[7]. However, an incidence of 0.6 – 28.3% has been reported in a systematic review [8]. An orthodontic bracket bond failure is said to have occurred when the bracket attachment to the enamel surface of a tooth ceases to be attached by the adhesive bond[6]. Failure

of bonded Orthodontic brackets is relatively frequent and this has many negative consequences on the outcome and length of treatment.

Rebonding brackets prolong clinic hours as the orthodontist would have to follow specific protocol each time there is a bond failure[7,8,9]. The overall treatment time is also lengthened and this may also result in treatment fatigue[8,9]. In addition, enamel fracture can occur as a result of orthodontic bracket failure[10] Several reasons account for bracket failure among which are operator-related factors like the bonding technique, patient-related factors including age, sex, general level of cooperation and compliance with dietary and oral hygiene instructions [11,12,13] . There are also material-related factors like the type of etchant or adhesive used alongside the bracket properties[11.]

Previous studies across the world[7,14,15,16] had studied the failure rates of light-cure and self-cure adhesives, with varying reports, including that both adhesive types have different failure rates and some claim similar failure rates[15]. Bishara et al [17] also reported greater use of the light-cure adhesive than the Self-cure adhesive. Several efforts to reduce bracket failure have been geared towards improvement in bonding technique, bracket bases, and adhesive technology[14].

Although there has been much research by adhesive-manufacturing companies regarding new advancement in adhesive technology in order to reduce bond failure[13]. Still, clinical studies are necessary in order to assess other contributory factors[12,18.]

Previous studies have been carried out in other regions of Nigeria on orthodontic bond failure but none has been done in the North Central Region. One of the peculiarities of this region is that it is semi-urban and the indigenes still operate a strong cultural and traditional system that enforces treatment compliance on their children.

The aims of this study were to determine the failure rate of Orthodontic brackets bonded using light-cure adhesive and to determine the effect of age and sex on bracket failure rate.

Materials and methods

The study was carried out at the Dental Department of the University of Ilorin Teaching Hospital, Ilorin, Kwara State, Nigeria.

This was a retrospective study, in which data of patients who had fixed orthodontic treatment done between 2015 to 2020 were used. A total of 101 patients (41 M, 60 F) records were retrieved from the health record and data on age of patients, sex, number of teeth bonded, and the rate of orthodontic bracket failure after using light cure adhesives were collected. The bonding procedure was performed by the same clinician and all teeth were bonded using the light cure adhesive system. Ethical approval was given by the ethical committee and informed consent obtained from the patients. Patients who had completed their treatment where the only ones included the study.

Bonding with light cure adhesive system: The following standard bonding procedure was carried out. The teeth were isolated using gauze roll and cheek retractor. Brush applicator was used to apply 37% of Phosphoric acid gel to the enamel surface of each tooth and left for 15 seconds. After adequate etching, the teeth were rinsed with water and dried with oil-free compressed air, until the enamel surface appeared frosty white.

A thin layer of Light Bond adhesive primer (Reliance Orthodontic Product, Light Bond ™ Sealant) was then smeared onto the etched tooth surface with a different brush applicator. The Light Bond light-cure adhesive was syringed onto the bracket base and placed in position on the tooth surface. Excess resin was removed by running a dental probe around the base of the bracket. The resin was polymerized using the Pow Dec LED-curing light model WP10050E. The light source was brought as close to the bracket as possible, as was recommended by the manufacturer.

Post Set-up Instructions and Reviews: Verbal and written oral hygiene and care of appliance instructions were given to each participant. They were also given an Ortho Survival kit which contained a soft-bristled toothbrush, an interdental brush, dental floss, and orthodontic wax. They were instructed not to tamper with the appliance or manipulate it. Instructions were given on brushing their teeth with a fluoride-containing toothpaste after every meal. Patients were counselled to take soft diet during the duration of the treatment because hard, large, and sticky pieces of food (nuts, crisps, chunky

meat and chewing gum) may damage the appliance. In order to determine bracket failure**,** patients were recalled every six weeks for wires and elastic module changes. During each visit, elastic modules and archwires were removed, brackets were examined, and debonded brackets were documented.

Analysis of the data was carried out using descriptive statistics (frequency, percentage, mean, and standard deviation. Student T-test was used to compare the bracket failure rate among the various age categories. Multiple linear regression analysis was used to ascertain if age and sex were significant predictors of bracket failure rates. 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 22.0 was used to analyze the data generated.

Results

As shown in Table 1, the participants were mostly females 60 (59.41%) while the males were 41 (40.59%). The mean age of participants was 16 ± 8.32. More than half of the study participants were less than 20 years of age.

Table 1. Distribution of participants by gender and age groups

Variable	Frequency(n=180)	Percentage
Sex		
Male	41	40.59
Female	60	59.41
Age groups		
≤ 12	37	36.6
13 – 19	39	38.6
20 – 29	19	18.8
≥ 30	6	5.9
Mean ± SD	16 ± 8.3	
Age Range	27 – 50	

Table 2. Gender Comparison of bracket failure

Sex	Frequency (n= 101)	Percentage	Bonded Brackets	Broken Brackets	Percentage
Male	41	40.59	527	69	13.1
Female	60	59.41	999	86	8.6
Total	101	100.0	1526	155	10.2

p-value =0.013

There were more male participants with a high rate of bond failure compared to females. Out of the 1526 teeth bonded using light cure composite, 155 (10.2%) failed, as shown in Table 2.

Table 3. Comparison of bracket failure among the Age group

Age Group	Frequency (n= 101)	Percentage	Bonded Brackets	Broken Brackets	Percentage Failure rate
≤ 12	37	36.6	359	57	15.9
13 – 19	39	38.6	692	69	10.0
20 – 29	19	18.8	367	23	6.3
≥ 30	6	5.9	108	6	5.6
Total	101	100	1526	155	10.2

p-value = 0.001

This indicates that there was statistically significant difference between the age groups in relation to bracket failure. The failure rate was highest in the age group under 12 years and progressively decreased as the age increased as see in Table 3

Table 4. Distribution of the number of brackets broken based on gender

Total broken bracket	0	1	2	3	4	5	6	8	9	12	Total
Male	17	11	3	0	6	2	1	0	0	1	41
Total broken	**0**	**11**	**6**	**0**	**24**	**10**	**6**	**0**	**0**	**12**	**69**
Female	24	14	10	7	1	2	0	1	1	0	60
Total broken	**0**	**14**	**20**	**21**	**4**	**10**	**0**	**8**	**9**	**0**	**86**
Overall	0	25	26	21	28	20	6	8	9	12	155

In Table 4, seventeen (17) out of forty-one (41) patients did not break any brackets while twenty-four (24) out of sixty (60) female patients did not break any bracket at all.

Table 5. Distribution of the number of brackets broken based on age groups

Age groups	0	1	2	3	4	5	6	8	9	12	Total
≤ 12	18	7	3	3	3	1	1	0	0	1	
Broken	**0**	**7**	**6**	**9**	**12**	**5**	**6**	**0**	**0**	**12**	**57**
13 – 19	14	7	7	3	4	3	0	1	0	0	

Broken	**0**	**7**	**14**	**9**	**16**	**15**	**0**	**8**	**0**	**0**	**69**
20 – 29	7	9	1	1	0	0	0	0	1	0	
Broken	**0**	**9**	**2**	**3**	**0**	**0**	**0**	**0**	**9**	**0**	**23**
≥ 30	2	2	2	0	0	0	0	0	0	0	
Broken	**0**	**2**	**4**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**6**
Total broken	**0**	**25**	**26**	**21**	**28**	**20**	**6**	**8**	**9**	**12**	**155**

Table 5 shows the distribution of broken brackets according to age with age group 13-19 years having the greatest number of broken brackets followed by under 12 years age group though in percentage the group has the greatest percentage of broken brackets.

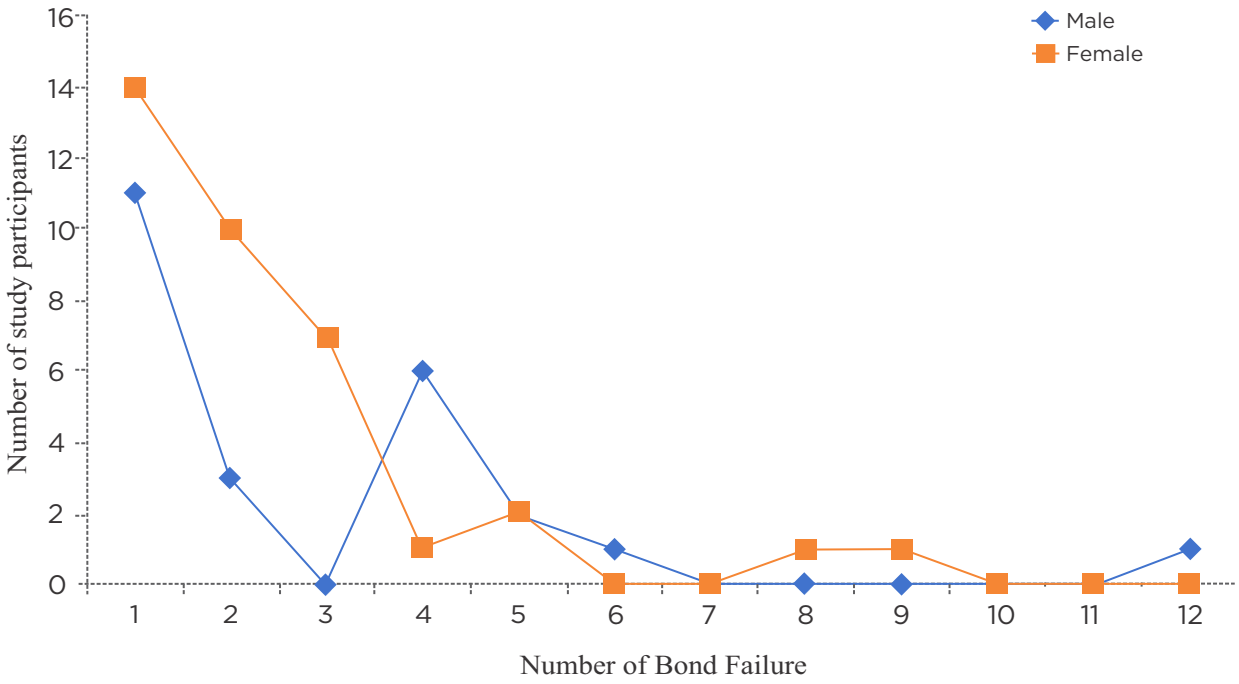

Figure 1: Number of bond failures based on gender. Females had lower bracket failure.

Table 6. Analysis of location of bond failure in male and female

Location Tooth Type	Gender Male (%)	 Female (%)	χ^2	p-value	Odd ratio	95 % C I
Upper right central incisor	6 (85.7)	1 (14.3)	6.350	**0.012**	10.114	1.169 – 87.519
Upper lateral Incisor	5 (62.5)	3 (37.5)	1.729	0.189	2.639	0.594 – 11.720
Upper right canine	2 (50.0)	2 (50.0)	0.153	0.696	1.487	0.201 – 11.006
Upper right first premolar	2 (50.0)	2 (50.0)	0.153	0.696	1.487	0.201 – 11.006

Upper right second premolar	9 (39.1)	14 (60.9)	0.026	0.871	0.924	0.357 – 2.392
Upper central left incisor	9 (69.2)	4 (30.8)	5.074	**0.024**	3.938	1.122 – 13.817
Upper left incisor	3 (50.0)	3 (50.0)	0.234	0.629	1.500	0.287 – 7.827
Upper left canine	2 (66.7)	1 (33.3)	0.873	0.351	3.026	0.265 – 34.516
Upper left first premolar	3 (42.9)	4 (57.1)	0.016	0.899	1.105	0.234 – 5.221
Upper left second premolar	8 (36.4)	14 (63.6)	0.209	0.648	0.797	0.300 – 2.116
Lower central right incisor	2 (40.0)	3 (60.0)	0.001	0.978	0.974	0.156 – 6.104
Lower lateral right incisor	3 (60.0)	2 (40.0)	0.821	0.365	2.289	0.365 – 14.349
Lower right canine	2 (40.0)	3 (60.0)	0.001	0.978	0.974	0.156 – 6.104
Lower right first premolar	1 (16.7)	5 (83.3)	1.514	0.218	0.275	0.031 – 2.446
Lower right second premolar	4 (23.5)	13 (76.5)	2.468	0.116	0.391	0.118 – 1.298
Lower central left incisor	3 (75.0)	1 (25.0)	2.044	0.153	4.658	0.467 – 46.440
Lower left lateral incisor	1 (25.0)	3 (75.0)	0.420	0.517	0.475	0.048 – 4.733
Lower left canine	2 (40.0)	3 (60.0)	0.001	0.978	0.974	0.156 – 6.104
Lower left first premolar	0 (0.0)	4 (100.0)	2.846	0.092	1.732	1.461 – 2.054
Lower left second premolar	2 (33.3)	4 (66.7)	0.139	0.709	0.718	0.125 – 4.115

Males have higher bond failure compared to female in brackets bonded on the upper right and left central incisors with a statistically P value of 0.012 and 0.024 respectively while in the posterior segment as seen in Table 6.

Table 7. Analysis of location of bond failure based on age

Location Tooth Type	Age Group < 20 (%)	 ≥ 20 (%)	χ^2	p-value	Odd ratio	95 % C I
Upper right central incisor	7 (100.0)	0 (0.0)	2.474	0.116	1.362	1.206 – 1.539
Upper lateral Incisor	8 (100.0)	0 (0.0)	2.858	0.091	1.368	1.209 – 1.547
Upper right canine	4 (100.0)	0 (0.0)	1.370	0.242	1.347	1.198 – 1.515
Upper right first premolar	4 (100.0)	0 (0.0)	1.370	0.242	1.347	1.198 – 1.515
Upper right second premolar	20 (87.0)	3 (13.0)	2.192	9.139	2.619	0.707 – 9.705
Upper central left incisor	11 (84.6)	2 (15.4)	0.703	0.402	1.946	0.401 – 9.448
Upper left incisor	6 (100.0)	0 (0.0)	2.098	0.147	1.357	1.203 – 1.530
Upper left canine	3 (100.0)	0 (0.0)	1.017	0.313	1.342	0.196 – 1.507
Upper left first premolar	5 (71.4)	2 (28.6)	0.059	0.808	0.810	0.147 – 4.459
Upper left second premolar	17 (77.3)	5 (22.7)	0.062	0.803	1.153	0.377 – 3.528
Lower central right incisor	4 (80.0)	1 (20.0)	0.064	0.801	1.333	0.142 – 12.518
Lower lateral right incisor	4 (80.0)	1 (20.0)	0.064	0.801	1.333	0.142 – 12.518
Lower right canine	5 (100.0)	0 (0.0)	1.730	0.188	1.352	1.201 – 1.523
Lower right first premolar	2 (33.3)	4 (66.7)	6.017	0.014	0.142	0.024 – 0.829
Lower right second premolar	11 (64.7)	6 (35.3)	1.220	0.269	0.536	0.175 – 1.640

Lower central left incisor	4 (100.0)	0 (0.0)	1.370	0.242	1.347	1.198 – 1.515
Lower left lateral incisor	3 (75.0)	1 (25.0)	0.001	0.991	0.986	0.098 – 9.933
Lower left canine	4 (80.0)	1 (20.0)	0.064	0.801	1.333	0.142 – 12.518
Lower left first premolar	3 (75.0)	1 (25.0)	0.001	0.991	0.986	0.098 – 9.933
Lower left second premolar	4 (66.7)	2 (33.3)	0.252	0.616	0.639	0.110 – 3.718

In Table 7, the brackets bonded on lower right first premolar in patients greater than age twenty have significantly higher bracket failure than patients lower than twenty years with a p-value of 0.014.

Discussion

The bracket failure rate using light-cure adhesive and a single practitioner over a 48-month period in this study was 10.2%. This is similar to that reported by Galindo et al[19] in which the failure rate was 11.3% after a study duration of eleven months. Le et al [20] had also reported a value of 11.3%. However, O'Brien et al [21] and Millet et al[22] reported a relatively much lower bracket failure rate, O'Brien et al[19] reported a failure rate of 3.9%, following a study duration that lasted through the entire treatment time while Millet et al[22] reported a failure rate of 6% over a 48-month study period. The lower value reported in the previous studies[19,20] may be as a result of dietary differences in individual societies, as African communities are known to have more abrasive diets which have also been reported to affect bond failure rate and the longer duration of the study period. The harder the diet, the higher the tendency for failure to occur. Although self-cure adhesive was not used in this study, Okeke et al[21] recorded a failure rate of 7.8%, which is similar to the finding by O'Brien et al[21] in which the self-cure adhesive was 7.5%. However, in a Nigeria-based study carried out in Lagos, South West, Moninuola et al[22] reported a higher failure rate of 24.1%. This higher value of the self-cure adhesive may be attributed to the longer study duration of 24 months.

In the present study, age and sex were found to be significant predictors of bracket failure rate. On the effect of age, there were more bracket failures in children and adolescents aged 7-19 years with a p-value of 0.001. There was a statistical difference between the age groups and bracket failure. This is in agreement with previous studies that reported a higher failure rate in younger age groups than in the adults.[20,23,24,25] This can be attributed to increased self-consciousness and self-motivation in adults while undergoing orthodontic treatment when compared to children and adolescents.[26,27] However, the finding of a more recent study,[28] the effect of sex on the failure rates of the light-cure bonded brackets was also investigated in the clinic study. In the present study, sex significantly affected the bracket failure rates, the failure rate in males was 13.1% while in females it was 8.6% with a p-value of 0.013.

Males were found in this study to break brackets in the upper central incisors compared to females,, and the lower right first premolar had a higher failure rate in the older age group.

This finding agrees with that of previous studies carried out in Nigeria[20,29,30] which reported that males have a higher failure rate for brackets. A Nigerian-based study by Moninuola and Ernest et al[24] reported the bracket failure rate in males as 26.2% and in females 23.4%. Aikins and Ututu[30] in a later study carried out at a tertiary health facility, reported a bracket failure rate of 81.2% for males and 69.2% for females. A similar finding has also been reported in a previous study in Europe[31] with males having a 2.4 times greater chance of bracket failure than females.

The reasons for the greater bracket failure rate in males may be the result of better oral hygiene exhibited by the females, including the fact that females tend to apply lighter masticatory forces than males.[24,32,33] Other possible explanations are that males engage more in physical activities which can predispose to traumatic bracket failure.[34] Males are also said to be involved in bad eating habits than females since they eat more junk food, which may contain hard food particles that may break off brackets.[35] Notwithstanding the findings, contradictory results have been reported in which females were reported as having more bracket failures.[19,24,26] This is similar to the report from several studies[27,31,32,33,34,36] which showed that sex was not a significant predictor of bracket failure rates.

A factor that could also be taken into consideration is the effect of a single practitioner bonding compared to multiple practitioners in bond failure. In a teaching hospital setting where registrars and consultants are involved in bonding brackets, there is greater possibility of higher failure rates.

Lastly, cultural and financial factors can improve patients compliance in following instructions that will prevent bracket failure. The population where the clinic is located is mainly of traditional settings in which parents exert great control and authority over their children to effect compliance. Many of the parents were struggling financially and could not cope with the cost of paying for broken brackets since they were still struggling with paying off the loan they incurred for the treatment. This may increase adherence to instructions and may also be a contributory factor to reduced incidence of bracket failure.

Conclusion

The bracket failure rate using light-cure adhesive was similar to other studies but lower compared to rates in Nigeria. Age and sex had significant influence on the bracket failure rates of orthodontic brackets.

Contribution to Authorship: All authors contributed equally to the manuscript.

Funding: Self funded

Conflict of Interest: No conflict of interest declared

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