10.5005/jp-journals-10024-1393

ORIGINAL RESEARCH

Long-Term Evaluation of Clinical Performance of Direct-bonded Brackets: An Epidemiologic Survey

Mohamad Hossein Ahangar Atashi, Mohamadreza Shahamfar

ABSTRACT

Aim: The objective of the current epidemiologic study was to investigate characteristics associated with bracket failure in bonded brackets.

Materials and methods: A retrospective study on data of 144 patients treated during 2009 to 2012 was done. Baseline data including age, gender, malocclusion, bite type and debonding incidences per teeth were retrieved. ANOVA analysis and t-test were used to evaluate the data.

Results: Second premolar teeth had significantly higher debonding incidences. Patients' age was negatively correlated with debonding incidences. No difference was observed for various types of malocclusion (class I, II and III), arch side (right or left) or arch location (upper or lower). However, deep bite patients had significantly higher failure incidents.

Conclusion: For a total of 144 patients with 2,524 bonded brackets, the overall failure rate was 7.8%. Deep bite was the only factor that was associated with higher bracket failure. The bracket failure incidents tend to decrease as patients age increase.

Clinical significance: Deep bite patients and also second premolar teeth seem to be especially prone to debonding incidents. Care must be taken to avoid premature contacts in deep bite patients. Also strict adherence to moisture control protocols when bonding second premolar teeth is recommended since these teeth are at increased risk for debonding.

Keywords: Bonding, Failure rate, Orthodontic brackets.

How to cite this article: Atashi MHA, Shahamfar M. Long-Term Evaluation of Clinical Performance of Direct-bonded Brackets: An Epidemiologic Survey. J Contemp Dent Pract 2013;14(4): 738-742.

Source of support: Nil

Conflict of interest: None declared

INTRODUCTION

One of the most common clinical problems encountered in the orthodontic treatments, is the accidental dislodgment of brackets. Rebonding these loose brackets require clinical chair time and is a nuisance in the course of orthodontic treatment. Bracket loosening occurs due to a variety of reasons ranging from biting trauma to inappropriate bonding technique. Epidemiologically, the prevalence of accidental debonding ranges from 3.5 to 23%.[1] Several methods have been proposed in the literature for reconditioning the bracket bases for rebonding purposes. Sandblasting,[2] laser treatment,[3] microetching[4] and grinding[4] are among the proposed techniques. Precoated brackets have also been proposed to reduce the chair time required for bonding.[5] However, results of a previous study, did not confirm the manufacturers claim on reduced bonding time.[6] In this study a grinding technique was utilized to rebond the dislodged brackets.

The bond strength of brackets should be in a range which resist every day biting forces but does not cause enamel damage in the final debonding session. Optimal bond strength has been reported to be 6 to 8 MPa.[7,8] Because *in vivo* evaluation of bond strength is virtually impractical, and given the limitations of laboratory investigations, studies on bracket failure protocols give useful information on both clinical performance of the bonded brackets and also the factors affecting it. On the other hand to the authors' knowledge, thus far, most bracket survival studies have been conducted in rather short span typically 6 to 26 months and in a small sample of patients.[1,9,10]

The aim of the current epidemiologic study is to retrospectively evaluate the clinical failure rate and also factors affecting it in a sample population of patients who underwent orthodontic treatment with a direct bonding technique during 2009 to 2012 period.

MATERIALS AND METHODS

A retrospective study was conducted to investigate the clinical performance of the bonded brackets. For this end, a

thorough search on the data of all patients whose treatments finished in the senior author's practice during the 2009 to 2012 period was conducted. A total of 144 patients with 2,524 attachments were studied. Baseline data including age (at the beginning of treatment), gender, malocclusion type (angle classification), and dental bite status (classified as normal bite, deep bite, reduced/open bite) were evaluated from the archives of the patients. Patients' classification according to bite was as follows: patients who had more than 4 mm of overbite were classified as deep bite, 2 to 4 mm as normal bite, and less than 2 mm as reduced/open bite. Frequency of first time debonding and also the total clinical services (per days) of the rebonded brackets were also retrieved. The clinical service of a rebonded bracket was achieved by calculating the total days of a rebonded bracket in which it served in the mouth without being dislodged. It was the office's policy to recommend the patients to refer to office, as soon as possible, when encountering a loose bracket. The author's procedure for rebonding was as follows: when encountering a loosed bracket, the author used a multiblade tungsten carbide bur (Torpedo, 123-582-00, Deantaurum Inc, Germany) to refresh the base of the bracket and also remove any remnant adhesives from the enamel surfaces of the teeth. The teeth were then etched with 35% phosphoric acid (Ultradent Products Inc, South Jordan, USA) for 15 seconds and washed for 20 seconds. After drying the tooth enamel, primer (Resilience, Orthotechnology, Tampa, USA) was applied to both enamel and refreshed bracket base followed by application of a no mix adhesive system (Resilience, Orthotechnology, Tampa, USA) to the bracket base. The mean treatment time was 22.2 ± 5.6 months. The brackets systems were from an18-slot brand (Equilibrium®, Dentaurum Inc, Germany).

The initial alignment arch wire was 0.014 inch NiTi (G&H wire company, Franklin, USA).

For statistical analysis of the data, SPSS 13 software was utilized. To study the effect of malocclusion and bite type on the frequency of debonding incidences, one-way analysis of the variances (ANOVA) was utilized. The relationship of age with bracket failure was studied by a Pearson correlation test, while the effect of gender was studied by an independent two-sample t-test analysis.

RESULTS

Demographic Characteristics

A total of 144 patients ranging from 9 to 38 years old (mean 18 ± 5.6) with 2524 attachments, whose treatment finished during 2009 to 2012 were studied. Data belonging to one patient was deficient and therefore was excluded from the study. The mean treatment duration was 22.2 months. Patients' distribution by age, gender, malocclusion and dental bite type are described in Table 1. Female patients comprised the majority of the population (80%). As for malocclusion type, class II dental relationship as well as normal dental overbite pattern represented the biggest group comprising almost half of the population.

Table 1: Demographic characteristics of patients

Distribution of patients	*No.*	*%*
By age		
9-19	74	51.5
19-29	62	43
29-28	8	5.5
By gender		
Male	29	20.1
Female	115	79.9
By malocclusion type		
Class I	44	30.6
Class II	83	57.6
Class III	16	11.8
By dental bite type		
Normal bite	66	45.8
Deep overbite	45	31.3
Reduced/open bite	32	22.2

Assessment of Bond Failures

Differential bracket failure rates per teeth and the mean clinical services of rebounded brackets are described respectively in Tables 2 and 3.

Second premolar teeth had the highest failure incidence rates, while canine teeth had the lowest (Table 2). One-way analysis of variance (ANOVA) indicated significant difference between the groups. A tukey's follow-up test indicated that second premolar teeth had significantly higher

Table 2: Descriptive statistics of failure incidence by tooth type, arch side, dental arch

	No. of bracket failure	*Failure incidence (%)*
Tooth type		
Upper incisor	24	4.1
Lower incisor	32	5.5
Upper canine	9	3.1
Lower canine	12	4.1
Upper 1st premolar	8	3.5
Lower 1st premolar	9	3.9
Upper 2nd premolar	54	21.2
Lower 2nd premolar	45	18.5
Arch side		
Right	85	6.8
Left	115	8.9
Dental arch		
Upper	102	8
Lower	98	7.7
Total	200	7.8

Table 3: Clinical services of the rebonded brackets according to tooth type

Tooth type	Mean time in clinical service (days)
Upper incisor	325
Lower incisor	312
Upper canine	375
Lower canine	369
Upper 1st premolar	327
Lower 1st premolar	318
Upper 2nd premolar	288
Lower 2nd premolar	296
Total (mean)	326.2

failure incidents compared to other teeth ($p < 0.05$). Sidewise analysis of the data by independent samples t-test, suggested no significant difference between the right and left sides ($p > 0.05$) nor did the dental arch analysis by the same test, yield any significant difference between upper and lower arch ($p > 0.05$).

Canine teeth had the highest clinical service time after rebonding while second premolar teeth had the lowest rates.

Factors Affecting Bond Failure

In this study, the effect of various background factors on failure incidences was studied.

Malocclusion

The mean failure incidences of brackets in various malocclusions are described in Table 4. One-way analysis of the variance, yielded no significant difference between the three angle calcifications groups ($p = 0.18$).

Table 4: Bond failure incidences by malocclusion type

Malocclusion	No. of patients	Failure incidence (%)	SD
Class I	44	7.4	4.32
Class II	83	8.3	4.44
Class III	16	7.7	4.59

Bite type

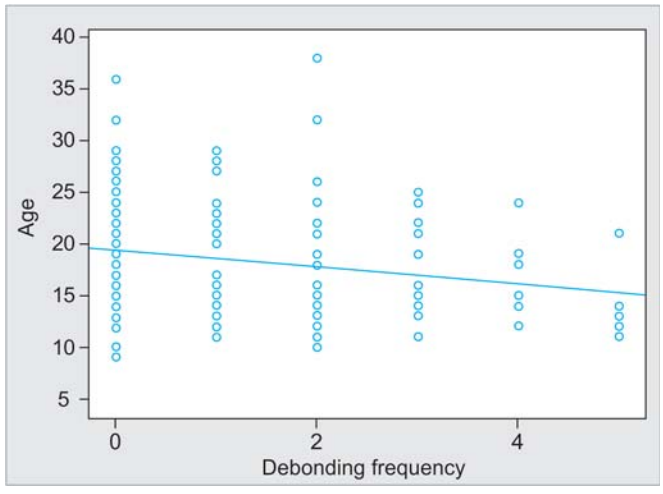
The mean debonding incidences by bite type can be seen in Table 5. Statistical analysis of the data indicated that there was a significant difference between the groups ($p < 0.05$). An LSD follow-up test indicated that deep overbite patients had significantly more bracket failure incidences than the other two groups ($p < 0.05$).

Table 5: Bond failure incidences by bite type

Bite type	No. of patients	Failure incidence (%)	SD
Deep bite	45	12.29	5.32
Normal bite	66	5.81	2.46
Reduced/open bite	32	5.42	2.23

Age

Graph 1 shows the correlation between patients' age and the debonding incidences. As seen in this figure, Pearson test indicated that there was a statistically significant and inverted correlation between patients' age and the debonding incidences ($p < 0.05$; $r = –0.21$). This meant that as patients' age increased, the bracket failure incidences decreased.



Graph 1: Correlation between patients' age and debonding frequency ($p < 0.05$; $r = –0.21$)

Gender

The distribution of bracket failure incidents according to gender are shown in Table 6. Independent two-sample t-test analysis revealed no significant difference between the two groups ($p > 0.05$).

Table 6: Distribution of bracket failure by gender

Gender	No. of bonded teeth	No. failed	Failure incidence (%)
Male	569	47	8.2
Female	1955	145	7.4

DISCUSSION

The overall failure rate observed in this study is comparable to those of previous reports.[6,11,12] Our study found a 7.8% bracket failure incidence, which is in close correlation with a previous report that found a 6.6% failure incidence.[6] In a post-treatment evaluation of direct bonding on 46 patients with almost seven hundred attachments, Zachrisson found 4 to 10% bracket debonding incidence for teeth from central incisors to first premolar teeth.[13] However, the author found a higher debonding incidence for the second premolar teeth. In our study with a higher sample population and higher attachment bondings, comparable results were achieved. A number of reasons can be attributed to the finding of increased debonding rates for the second premolar teeth.

Difficulty of reaching the buccal surfaces of these teeth and subsequent moisture contamination, presence of aprismatic enamel[14] and also premature occlusal contacts can be listed on the etiology of this finding.

In the current study lower incisors had the second highest debonding incidents after second premolar teeth. This was not surprising when taken into account the finding that deep over bite cases had also the highest rate of bracket failure, which might imply that possible premature contacts on the lower incisors might have contributed to the high incidents of debondings observed in these teeth.

An interesting finding from our study was that the clinical services of the Rebonded brackets were also in harmony with the frequency of the debonding incidences of the respective teeth. In other words, teeth with the highest debonding incidents had also, a low clinical service per days when rebonded. An explanation may be that the factors responsible for the first time debondings have persisted resulting in shorter clinical services of the rebonded brackets.

Some previous studies have reported a higher failure rate for lower arch.[1,10,13,15,16] The reason of their finding may be attributed to the higher occlusal interferences observed in mandible or difficulty of moisture control in the mentioned area. However in the current study, we found no such difference between the arches. Similarly in the sidewise comparison, no difference between the right and left sides were noted. This was in agreement with finding of a previous long term study on the failure rates of brackets[16] but disagreed with some others.[6,10] Furthermore, in our study, though a slightly higher failure rate was observed in favor of male participants, no meaningful difference was noted.

As mentioned by Pandis and Eliades,[10,17] the differences of clinical failure rates regarding arch location, arch quadrant and gender, in different populations, indicate the complex nature of clinical failure protocols and highlights the influence of cross factors like culturally influenced dietary habits, socioeconomic status of the populations, oral habits and masticatory forces associated with various facial types of the populations. Indeed the mentioned parameters must be taken into account when interpreting the of bracket failure researches.

Another factor that might be influential on bracket failure is the effect of malocclusion and mechanotherapy.

The authors in the current study used an 18-slot bracket system from a single brand type and also bonding system for all patients. The usual initial alignment arch wire used for the patient was 0.014 inch NiTi arch wire. In our study we found no difference between the various Angle malocclusion types regarding the frequency of debonding incidences. However, in a previous prospective study on 63 patients, Bherwani et al[18] found significantly higher debonding incidences in class II division 2 malocclusions. The authors in that study, had not systematically investigated the bite type per debonding incidences, but it is noteworthy that class II division 2 patients often have a deep bite tendency which might be responsible for the higher failure rates observed, similar to what we found in our study.

Finally, it has to be mentioned that the current study reported the epidemiologic characteristics of the debonded brackets postoperatively.

As mentioned previously, unknown confounders in the populations might influence the trends in bracket failure protocols.

Further controlled studies are recommended to clarify the effects of the fore-described factors.

CONCLUSION

For a population of 144 patients with 2,524 attachments, a 7.8 % failure incidence was noted. Bracket failure was not different in various malocclusions, arch sides, arch locations or genders. Deep bite patients had significantly higher bracket failure incidents. The bracket failure incidents tend to decrease as patients age increase.

CLINICAL SIGNIFICANCE

Deep bite patients and also second premolar teeth seem to be especially prone to debonding incidents. Care must be taken to avoid premature contacts in deep bite patients. Also strict adherence to moisture control protocols when bonding second premolar teeth is recommended since these teeth are at increased risk for debonding.

REFERENCES

1. Lovius BB, Pender N, O'Dowling I, Tomkins A. A clinical trial of light activated bonding material over an 18-month period. Br J Orthod 1987;14:11-20.
2. Tavares SW, Consani S, Nouer DF, Magnani M, Nouer P, Martins L. Shear bond strength of new and recycled brackets to enamel. Braz Dent J 2006;17(1):44-48.
3. Ishida K, Endo T, Shinkai K, Katoh Y. Shear bond strength of rebonded brackets after removal of adhesives with Er, Cr:YSGG laser. Odontology 2011;99(2):129-134.
4. Eminkahyagil N, Arman A, Cetinsahin A, Karabulut E. Effect of resin removal methods on enamel and shear bond strength of rebonded brackets. Angle Orthod 2006 Mar;76(2):314-321.
5. The APC™ adhesive coated appliance system. 3M Unitek product Brochure (1995).
6. Sunna S, Rock WP. Clinical performance of orthodontic brackets and adhesive systems: a randomized clinical trial. Br J Orthod 1998;25:283-287.
7. Keizer S, Ten Cate GM, Arends J. Direct bonding of orthodontic brackets. Am J Orthod 1976;69:318-327.

8. Akin-Nergiz N, Nergiz I, behlfelt K, Platzer U. Shear bond strength of new polycarbonate bracket—an in vitro study with 14 adhesives. Eur J Orthod 1996;18:295-301.
9. Romano FL, Valerio RA, Silva JM, Ferreira JTL, Faria G, Borsatto MC. Clinical evaluation of the failure rate of metallic brackets bonded with orthodontic composites. Braz Dent J 2012;23:399-402.
10. Pandis N, Christensen L, Eliades T. Long term clinical failure rate of molar tubes bonded with a self-etching primer. Angle Orthod 2005;75:1000-1002.
11. Santos JE, Quioca J, Loguercio AD, Reis A. A 6-month bracket survival with a self-etch adhesive. Angle Orthod 2006;76:863-868.
12. O' Brien KD, Read MJF, Sandison RJ, Roberts CT. A visible light-activated direct bonding material: an in vivo comparative study. Am J Orthod Dentofacial Orthop 1989;95:335-348.
13. Zachrisson BU. A post-treatment evaluation of direct bonding in orthodontics. Am J Orthod 1977;71:173-189.
14. Whittacker DK. Structural variation in the surface zone of human teeth enamel observed by scanning electron microscopy. Arch Oral Biology 1982;27:383-392.
15. Trimpeneers LM, Dermaut LR. A clinical trial comparing failure rates of two orthodontic bonding systems. Am J Orthod Dentofacial Orthop 1994;106:127-130.
16. Pandis N, Strigou S, Eliades T. Long term failure rate of brackets bonded with plasma and high intensity light-emitting diode curing lights. A clinical assessment. Angle Orthod 2007;77:707-710.
17. Pandis N, Eliades T. A comparative in vivo assessment of the long term failure rate of two self-etching primers. Am J Orthod Dentofacial Orthop 2005;128:96-98.
18. Bherwani A, Fida M, Azam I. Bond failure with a no-mix adhesive system. An 18-month clinical review. Angle Orthod 2008;78:545-548.

ABOUT THE AUTHORS

Mohamad Hossein Ahangar Atashi

Associate Professor, Department of Orthodontics, Tabriz School of Dentistry, Iran

Mohamadreza Shahamfar (Corresponding Author)

Resident, Department of Orthodontics, Tabriz School of Dentistry Iran, e-mail: mohamadreza_shr@yahoo.com