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INTRODUCTION

Orthodontic treatment enhances patients’ physical appearance by correcting malocclusion of teeth. The treatment also improves oral health conditions that are related to malocclusions. These conditions include, mastication difficulties with potential to cause digestion problems, speech impairments, abnormal loading of temporomandibular joints that can lead to severe inflammation and pain, headaches or pain in the patients’ face and neck. Orthodontists use various removable and fixed appliances to treat orthodontic problems. The main components of the fixed orthodontic appliances are brackets that are attached to the teeth using different types of adhesives. The movement of teeth depends on the wires and springs attached to these brackets. Therefore, it is of utmost importance that these brackets remain attached to the teeth during the course of orthodontic treatment. However, brackets...
Bracket detachment “debonding” from the teeth remains one of the major concerns during orthodontic treatment with fixed appliances. The bracket bonding procedure plays a major role in achieving an optimal outcome during orthodontic corrective procedures, as the required tooth movement relies upon it. Bracket detachment during corrective procedures may also lead to increased treatment duration, damage to tooth enamel, and increased chairside-time due to re-bonding procedure. Consequently, it could also raise the costs of the overall orthodontic treatment.

Recent advancements in dental materials and bonding techniques has helped to make orthodontic brackets bonding easier, efficient, predictable, and effective. Orthodontic bonding technique has changed significantly since it was first used in 1950s. At present, there are direct and indirect bonding techniques used in orthodontic treatment with fixed appliances. However, both the techniques have advantages and disadvantages in relation to bond failure rates. Although indirect bonding technique has more advantages in terms of shorter initial bonding appointment, higher degree of precision, and more focused results, yet the majority of the orthodontists prefer the direct bonding technique to avoid laboratory involvement.

Bracket detachment is a major concern during orthodontic treatment with fixed appliances, as it can be irritating and in some instances critical in the overall success of the treatment. Presently, there is a tendency towards bonding brackets on all the teeth for providing full arch orthodontic treatment, thus making bracket detachment more critical. Previous studies have reported varying incidence of bracket failure following orthodontic brackets bonding. Several studies have also compared various techniques of orthodontic bonding and rates of brackets detachment. However, there are no systematic reviews available on incidence of orthodontic brackets detachment during orthodontic treatment. Therefore, the current study aimed to summarize the evidence regarding the incidence of orthodontic brackets detachment during orthodontic treatment.

METHODS

Search Strategies: The electronic databases, PubMed and Web of Science were searched from their inception up to January 2018. Only studies published in the English language were included. The databases were searched using the following keywords: (“Orthodontic treatment” OR “Dental procedures”) AND (“Brackets detachment” OR “Bracket de-bonding” OR “Bracket bonding” OR “Bracket failure”) AND (“Prevalence” OR “Incidence”). Additionally, the studies were searched manually from the reference lists of the studies identified through databases.

Study Selection: All the studies investigating brackets detachment during orthodontic treatment with fixed appliances were included. Studies were required to report the incidence of brackets failure as one of the study outcomes.

Data Extraction: Both authors independently screened the titles and abstracts to exclude irrelevant articles. Full texts of the potential articles were then evaluated to identify eligible studies. Following data were extracted from the included studies: author(s), year of publication, study design, bonding technique used, total number of brackets used, number and incidence of bracket failure, and conclusions. Both authors discussed and reached to an agreement on an agreement on the quality of the collected data.

Quality Assessment: Both authors evaluated the quality of all the selected studies using the Coleman Methodology Scoring (CMS) system. The CMS has ten sections with a total of 100 points. Additionally, the Cochrane Collaboration’s tool was used to assess the risk of bias in the included studies. Risk of bias was presented as low, unclear, or high for each included study. Both the authors discussed and reached to an agreement on the quality assessment.

Outcome Measure: The outcome evaluated in this systematic review was the incidence of brackets detachment during orthodontic treatment with fixed appliances.

RESULTS

Study Selection: Based on the titles and abstracts, 222 articles were initially identified. After excluding duplicates and screening the abstracts, 189 studies were not found relevant to objective of this review. Further sixteen articles were excluded due to not matching the inclusion criteria. Therefore, a total of seventeen studies were included in the final synthesis. Among the 17 included studies, thirteen were categorized as RCTs, one
Table I: Study characteristics and incidence of orthodontic bracket detachment during orthodontic treatment.

| Authors            | Participants | Study design                      | Bracket numbers | Brackets type | Malocclusion class | Adhesive system                  | Bracket detachment incidence no. (%) | Observation Period (months) | Conclusions                                                                 |
|--------------------|--------------|-----------------------------------|-----------------|---------------|--------------------|-----------------------------------|--------------------------------------|-------------------------------|-----------------------------------------------------------------------------|
| Sfondrini et al. 2004 | a: 83  b: 17.3 (4.5)  c: 35/48  | “split-mouth” with randomization | 1434            | stainless steel | I, II, III          | Halogen light versus plasma arc light | 70 (4.9)                             | 12                           | No significant differences between both techniques.                           |
| Cacciafesta et al. 2004 | a: 30  b: 16.7 (3.2)  c: 12/18 | “split-mouth” with randomization | 600             | stainless steel | I, II, III          | Halogen light versus plasma arc light | 33 (5.5)                             | 12                           | As above                                                                     |
| Krishnaswamy et al. 2007 | a: 30  c: 15/15 | “split-mouth” with randomization | 544             | stainless steel | I, II, III          | Light-emitting diode (LED) lamp vs halogen light | 41 (7.5)                             | 15                           | As above                                                                     |
| Elekdag-Turk et al. 2008 | a: 37  b: 16.5  c: 14/23 | “split-mouth” with randomization | 672             | metal          | I, II              | self-etching primer versus conventional | 4 (0.6)                             | 6                            | Improved bracket survival rate with self-etching primer than the conventional method. |
| Koupis et al. 2008 | a: 37  c: 12/15 | “split-mouth” with randomization | 600             | nickel-titanium & stainless steel | I, II, III | Light-emitting diode (LED) lamp vs halogen light | 25 (4.20)                             | 9                            | No significant differences between both techniques.                           |
| Varlik et al. 2009 | a: 30  Age range 14 - 21  c: 14/16 | universal numbering system, odd-numbered teeth as control group, even-numbered teeth experimental group. | 544             | Stainless steel Mini Ovation | I, II, III | highly filled light-cured sealant (HFLCS) versus conventional adhesive | 18 (3.3)                             | 18                           | ProSeal can be used as a preventive measure without affecting the bonding properties of metal brackets. |
| Campoy et al. 2010 | a: 46  c: 14/16 | prospective controlled clinical trial | 531             | Stainless steel | ?                  | saliva contamination before bonding versus after bonding | 37 (7.1)                             | 6                            | Either before or after bonding, no significant increase in bracket detachment with saliva contamination |
| Romano et al. 2012 | a: 19  Age range 11-39  c: 7/12 | ?                               | 380             | nickel-titanium | I, II, III          | Transbond XT (TXT) composite versus Transbond Plus Color Change (TPCC) | 6 (1.6)                             | 6                            | With both TXT or TPCC methods, a few brackets detached                      |
| Romano et al. 2012b | a: 20  Age range 11-15  c: 7/13 | ?                               | 400             | nickel-titanium | I, II, III          | Conventional Transbond XT Versus Transbond XT + Transbond Plus Self Etching Primer (TIPSEP) adhesive systems Versus Orthodontic Concise and Transbond XT without primer | 20 (5)                             | 6                            | Fewer brackets failures with conventional Transbond XT and Transbond XT+TIPSEP than Orthodontic Concise and Transbond XT without primer. |
| Hammad et al. 2013 | a: 30  b: 14 (7)  c: 10/20 | “split-mouth” with randomization | 538             | straight-wire | ?                  | Conventional adhesive versus Amorphous calcium phosphate-containing adhesive | 11 (2.04); 17 (3.1)                    | 6                            | The ACP-containing adhesive seems to be an alternative to conventional adhesives. |
| Bovali et al. 2014 | a: 64  b: 18.5 (4.8)  c: 29/35 | Randomized controlled trial | ?               | ?              | ?                  | Indirect vs direct bonding | 17 (28.3)                             | 6                            | Indirect bonding was statistically significantly faster than direct bonding. Both techniques showed similar risks of failure. |
As per our knowledge, this is the first systematic review on the incidence of brackets detachment during orthodontic treatment. An increase in incidence of bracket failure is expected with increase in the follow-up period. However, this was not evident from the results of the current review. Only one study reported very high incidence of brackets detachment (28.3%), while others reported relatively lower incidences ranging from 0.6% to 9.6%.

**DISCUSSION**

Trials originated from the Netherlands, Brazil, Turkey, Greece, Spain, Switzerland, Italy, and Korea. The number of patients ranged from 19 to 153, with the mean age from 10.5 to 38.7 years. The male to female ratio was 333.495:1. In most of the studies, patients were distributed as class I, II, and III malocclusion, and stainless steel brackets were used. In all the studies, three techniques were used to bond brackets: direct bonding, indirect bonding, and self-ligating brackets. The studies compared the Halogen light technique with the other adhesive systems on brackets detachment after orthodontic bonding, while three studies compared direct versus indirect bonding during orthodontic treatment.

**Table 1**

| Study | Design | Sample Size | Molar Tubes vs. Anterior Brackets | Bracket Detachment Rate (%) |
|-------|--------|-------------|----------------------------------|-----------------------------|
| Jung 2014* | Prospective cohort study | 3061 | I, II, III | 176 (5.7) |
| Menini et al. 2014* | Clinical trial | 1248 | I, II, III | 54 (4.32) |
| Ozer et al. 2017 | Clinical trial | 1140 | Self-ligating metal | 26 (2.57) |
| Vijayakumar et al. 2014* | Clinical trial | 518 | Stainless steel | 30 (9.6) |
| Bazargani et al. 2016 | Single-operator, crossmouth, randomized controlled trial (RCT) | 908 | Metal | 39 (4.2) |
| Roekofs et al. 2017 | Retrospective survey | 3336 | Metal and tubes | 83 (2.5) |

*Bracket detachment rate for molars was greater than anterior teeth.
Orthodontic brackets detachment

Table II: Methodological quality assessment of included studies based on Coleman Methodology Scoring.28

| Study                      | Criteria | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Score | Scores (%) |
|----------------------------|----------|---|---|---|---|---|---|---|---|---|----|----|----|-------|-------------|
| Sfondrini et al. 2004      | Yes Yes Yes No N/A Yes N/A Yes Yes No No Yes | 7/10 | 70   |
| Cacciafesta et al. 2004    | Yes Yes Yes No N/A Yes N/A Yes Yes No No Yes | 7/10 | 70   |
| Krishnaswamy et al. 2007   | Yes Yes Yes No N/A Yes N/A Yes Yes No No Yes | 7/10 | 70   |
| Elekdag-Turk et al. 2008   | Yes Yes Yes No N/A Yes N/A Yes Yes No No Yes | 7/10 | 70   |
| Koupis et al. 2008         | Yes Yes Yes No N/A Yes N/A Yes Yes No No Yes | 7/10 | 70   |
| Varlik et al. 2009         | Yes No No No N/A Yes N/A Yes Yes No Yes Yes | 6/10 | 60   |
| Campoy et al. 2010         | Yes Yes No No N/A Yes N/A Yes Yes No No Yes | 6/10 | 60   |
| ROMANO et al. 2012         | Yes No Yes No N/A Yes N/A Yes Yes No Yes Yes | 6/10 | 60   |
| ROMANO et al. 2012b        | Yes Yes Yes No N/A Yes N/A Yes Yes No No Yes | 7/10 | 70   |
| Hammad et al. 2013         | Yes Yes No No N/A Yes N/A Yes Yes No No Yes | 6/10 | 60   |
| Bovali et al. 2014         | Yes Yes No Yes N/A Yes N/A Yes Yes No Yes Yes | 8/10 | 80   |
| Jung 2014                  | Yes No Yes No N/A Yes N/A Yes Yes No No Yes | 6/10 | 60   |
| Menini et al. 2014         | Yes Yes No No N/A Yes N/A Yes Yes No No Yes | 7/10 | 70   |
| Ozer et al. 2014           | Yes Yes No No N/A Yes N/A Yes Yes No No Yes | 6/10 | 60   |
| Vijayakumar et al. 2014    | Yes No No No N/A Yes N/A Yes Yes No No Yes | 5/10 | 50   |
| Bazargani et al. 2016      | Yes Yes Yes Yes N/A Yes N/A Yes Yes No Yes Yes | 9/10 | 90   |
| Roelofs et al. 2017        | Yes No No No N/A Yes N/A Yes Yes No No Yes | 5/10 | 50   |

N/A: Not applicable.

Relatively low incident (0.6% to 9.6%).1,4,20,21,23,24,27,30-38 The finding could be attributed to several factors. Firstly, the type of adhesive resin used for bracket bonding could affect the bracket survival. Varlike et al.21 concluded that highly filled light-cured sealant can be used as a preventive measure without affecting the bonding properties of metal brackets. Similarly, Romano et al.4 reported less number of bracket failure following the application of Transbond XT (TXT) composite or Transbond Plus Color Change (TPCC). Furthermore, Hammad et al.35 have recommended using amorphous calcium phosphate-containing adhesive to minimize risk of bracket failure. Secondly, direct and indirect bonding technique could be another reason for different rates of bracket detachment during orthodontic treatment. Indirect bonding technique is significantly faster than direct bonding, however, both techniques have shown similar risks of brackets bonding failure.22,23,38 Out of the seventeen studies included in this review, eight studies1,4,22,33,35-38 had low CMS score (≤ 60%), which indicates low methodological quality. Various items were not met by most of the included studies, therefore, future studies investigating incidence of brackets detachment after orthodontic treatment considering these items are recommended. The lack of information about the sample size estimation and dropouts could
Of the seventeen studies included in this review, almost all the included studies had a high risk of bias, while only one study had an unclear risk of bias. Several items including allocation concealment and blinding of participants, personnel and outcome assessor were not met by most of the included studies. A previous study has reported the importance of blinding to reduce the performance and detection bias.

Limitations: It was heterogeneity among the studies as related to patients’ selection criteria, treatment techniques, outcome criteria, and length of follow-up, indicating lack of sufficient body of literature available on this topic. The present review did not assess the factors associated with brackets detachment during orthodontic treatment. Nevertheless, the present review has provided new evidence-based information on incidence of bracket failure during orthodontic treatment. Orthodontists need to adopt all the possible measures to prevent bracket failure during treatment with fixed orthodontic appliances.
CONCLUSIONS

The present review indicates a high incidence of brackets detachment during orthodontic treatment. However, more high quality studies with larger samples are recommended to improve the evidence on the prevalence and incidence of brackets detachment during orthodontic treatment.

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REFERENCES

1. Roelofs T, Merkens N, Roelofs J, Bronkhorst E, Breuning H. A retrospective survey of the causes of bracket- and tube-bonding failures. Angle Orthod. 2017;87(1):111-117.

2. Bishara SE, VonWald LBA, Laffoon JF, Warren JJ. The effect of repeated bonding on the shear bond strength of a composite resin orthodontic adhesive. Angle Orthod. 2000;70(6):435-441.

3. Bishara SE, Laffoon JF, VonWald L, Warren JJ. The effect of repeated bonding on the shear bond strength of different orthodontic adhesives. Am J Orthod Dentofacial Orthop. 2002;121(5):521-525.

4. Romano FL, Valero RA, Gomes-Silva JM, Ferreira JT, Faria GI, Borsatto MC. Clinical evaluation of the failure rate of metallic brackets bonded with orthodontic composites. Braz Dent J. 2012;23(4):399-402.

5. Millett DT, Mandall NA, Mattick RC, Hickman J, Glenny AM. Adhesives for fixed orthodontic brackets. Cochrane Database Syst Rev. 2011;15(6):CD008236.

6. Minick GT, Oesterle LJ, Newman SM, Shellhart WC. Bracket bond strengths of new adhesive systems. Am J Orthod Dentofacial Orthop. 2009;135(6):771-776. doi: 10.1016/j.ajodo.2007.06.021.

7. Buonocore MG. A simple method of increasing the adhesion of acrylic filling materials to enamel surfaces. J Dent Res. 1955;34(6):849-853.

8. Newman GV. Epoxy adhesives for orthodontic attachments: Progress report. Am J Orthod. 1965;55(12):901-912.

9. Silverman E, Cohen M, Gianelly AA, Dietz VS. A universal direct bonding system for both metal and plastic brackets. Am J Orthod. 1972;62(6):593-594.

10. Zachrisson BU, Brobakken BO. Clinical comparison of direct versus indirect bonding with different bracket types and adhesives. Am J Orthod. 1978;74(1):62-78.

11. Read MJ, Brien KD. A clinical trial of an indirect bonding technique with a visible light-cured adhesive. Am J Orthod Dentofacial Orthop. 1990;98(3):259-262.

12. Aguirre MJ, King GJ, Waldron JM. Assessment of bracket placement and bond strength when comparing direct bonding to indirect bonding techniques. Am J Orthod Dentofacial Orthop. 2010;137(5):679-683.

13. Chapman JR. Bond failure rates of two self-ligating brackets: a randomised clinical trial. Aust Orthod J. 2011;27(2):139-144.

14. Menini A, Cozzani M, Sfondrini MF, Scribante A, Cozzani P, Gandini P. A 15-month evaluation of bond failures of orthodontic brackets bonded with direct versus indirect bonding technique: a clinical trial. Prog Orthod. 2014;15(70). doi: 10.1186/s40510-014-0070-9.

15. Murray PG, Millett DT, Cronin M. Bonded molar tubes: a survey of specialist orthodontists. J Orthod. 1979;13(1):39-53.

16. Silverman E, Cohen M, Gianelly AA, Dietz VS. A universal direct bonding system for both metal and plastic brackets. Am J Orthod. 1972;62(6):593-594.

17. Zachrisson BU, Brobakken BO. Clinical comparison of direct versus indirect bonding with different bracket types and adhesives. Am J Orthod. 1978;74(1):62-78.

18. Read MJ, Brien KD. A clinical trial of an indirect bonding technique with a visible light-cured adhesive. Am J Orthod Dentofacial Orthop. 1990;98(3):259-262.

19. Aguirre MJ, King GJ, Waldron JM. Assessment of bracket placement and bond strength when comparing direct bonding to indirect bonding techniques. Am J Orthod Dentofacial Orthop. 2010;137(5):679-683.

20. Krishnaswamy NR, Sunita C. Light-emitting diode vs halogen light curing of orthodontic brackets: a 15-month clinical study of bond failures. Am J Orthod Dentofacial Orthop. 2007;132(4):518-523.

21. Varlik SK, Demirbas E. Effect of light-cured filled sealant on the bond failure rate of orthodontic brackets in vivo. Am J Orthod Dentofacial Orthop. 2009;135(2):144.e1-4; discussion 144-145. doi: 10.1016/j.ajodo.2008.05.013.

22. Bovall E, Kiliaridis S, Cornelis MA. Indirect versus direct bonding of mandibular fixed retainers in orthodontic patients: a single-center randomized controlled trial comparing placement time and failure over a 6-month period. Am J Orthod Dentofacial Orthop. 2014;146(6):701-708.

23. Bishara SE, Laffoon JF, VonWald L, Warren JJ. The effect of repeated bonding on the shear bond strength of different orthodontic adhesives. Am J Orthod Dentofacial Orthop. 2002;121(5):521-525.

24. Bishara SE, Laffoon JF, VonWald L, Warren JJ. The effect of repeated bonding on the shear bond strength of different orthodontic adhesives. Am J Orthod Dentofacial Orthop. 2002;121(5):521-525.

25. Aguirre MJ, King GJ, Waldron JM. Assessment of bracket placement and bond strength when comparing direct bonding to indirect bonding techniques. Am J Orthod Dentofacial Orthop. 2010;137(5):679-683.

26. Chapman JR. Bond failure rates of two self-ligating brackets: a randomised clinical trial. Aust Orthod J. 2011;27(2):139-144.

27. Bazargani F, Magnuson A, Lothgren H, Kowalczyk A. Orthodontic bonding with and without primer: a randomized controlled trial. Eur J Orthod. 2016;38(5):503-507.

28. Coleman BD, Khan KM, Maffulli N, Cook JL, Wark JD. Studies of surgical outcome after patellar tendinopathy: clinical significance of methodological deficiencies and guidelines for future studies. Victorian Institute of Sport Tendon Study Group. Scand J Med Sci Sports. 2000;10(1):2-11.

29. Savovic J, Weeks L, Sterne JA, Turner L, Altman DG, Moher D, et al. Evaluation of the Cochrane Collaboration’s tool for assessing the risk of bias in randomized trials: focus groups, online survey, proposed recommendations and their implementation. Syst Rev. 2014;3:37. doi: 10.1186/2046-4053-3-37.

30. Sfondrini MF, Cacciafesta V, Scribante A, Klersy C. Plasma arc bonding with and without primer: a randomized controlled trial. Eur J Orthod. 2004;26(4):449-454.

31. Koupis NS, Eliades T, Athanasiou AE. Clinical evaluation of bracket bonding with and without primer: a randomized controlled trial. Eur J Orthod. 2004;26(4):449-454.

32. Chapman JR. Bond failure rates of two self-ligating brackets: a randomised clinical trial. Aust Orthod J. 2011;27(2):139-144.

33. Bishara SE, Laffoon JF, VonWald L, Warren JJ. The effect of repeated bonding on the shear bond strength of differen...