This is the published version of a paper published in *Pakistan journal of medical sciences print*.

Citation for the original published paper (version of record):

Incidence of orthodontic brackets detachment during orthodontic treatment: A systematic review
*Pakistan journal of medical sciences print, 34*(3): 744-750
https://doi.org/10.12669/pjms.343.15012

Access to the published version may require subscription.

N.B. When citing this work, cite the original published paper.

Permanent link to this version:
http://urn.kb.se/resolve?urn=urn:nbn:se:umu:diva-150396
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

ABSTRACT

Objectives: To evaluate the incidence of orthodontic brackets detachment during orthodontic treatment.

Methods: Using electronic databases; eligible studies up to January 2018 were retrieved, independently reviewed, and screened. The Coleman Methodology Scoring System (CMS) and Cochrane Collaboration's tool were used to assess quality and risk of bias in the included studies.

Results: Of the seventeen studies included in the final synthesis, thirteen were categorized as randomized clinical trials (RCTs), one prospective cohort and retrospective survey each, whereas two studies could not be categorized. The number of patients in the selected studies ranged between 19 and 153; the mean age was between 10.5 to 38.7 years, and male to female ratio was 353:495. Almost all studies had a high risk of bias, and more than half of the studies had CMS score of 70 or above. The numbers of brackets examined in the studies ranged between 361 and 3336. The incidence of brackets detachment ranged from 0.6 to 28.3%.

Conclusions: The incidence of brackets detachment during orthodontic treatment is high.

KEYWORDS: Orthodontic treatment, Brackets detachment, Bracket de-bonding, Bracket failure, Prevalence, Incidence.

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detachment “debonding” from the teeth remains one of the major concerns during orthodontic treatment with fixed appliances.\textsuperscript{13} 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.\textsuperscript{4} 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.\textsuperscript{2,3} Consequently, it could also raise the costs of the overall orthodontic treatment.\textsuperscript{4}

Recent advancements in dental materials and bonding techniques has helped to make orthodontic brackets bonding easier, efficient, predictable, and effective.\textsuperscript{6} Orthodontic bonding technique has changed significantly since it was first used in 1950s.\textsuperscript{7} At present, there are direct and indirect bonding techniques used in orthodontic treatment with fixed appliances.\textsuperscript{8,9} However, both the techniques have advantages and disadvantages in relation to bond failure rates.\textsuperscript{10-12} 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.\textsuperscript{13}

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.\textsuperscript{14-16} Previous studies have reported varying incidence of bracket failure following orthodontic brackets bonding.\textsuperscript{17,18} Several studies have also compared various techniques of orthodontic bonding and rates of brackets detachment.\textsuperscript{19-27} 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 debonding” 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 included studies. Risk of bias was presented as low, unclear, or high for each included study.\textsuperscript{28} 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.\textsuperscript{1,4,20-24,27,30-38} The inter-assessor agreement was very good to excellent for initial screening and full-text eligibility ($k = 0.81$ and $0.94$ respectively). Figure 1 presents details of study selection process and results of the literature search as per PRISMA guidelines.\textsuperscript{24}

Characteristics of Included Studies: Table-I displays the characteristics of all included studies. Among the 17 included studies,\textsuperscript{1,4,20-24,27,30-38} thirteen\textsuperscript{20-24,27,30-33,35,37,38} were categorized as RCTs, one
<table>
<thead>
<tr>
<th>Authors</th>
<th>Participants</th>
<th>Study design</th>
<th>Bracket numbers</th>
<th>Brackets type</th>
<th>Malocclusion class</th>
<th>Adhesive system</th>
<th>Bracket detachment incidence no. (%)</th>
<th>Observation Period (months)</th>
<th>Conclusions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sfondrini et al. 2004</td>
<td>a: 83</td>
<td>“split-mouth” with randomization</td>
<td>1434</td>
<td>stainless steel</td>
<td>I, II, III</td>
<td>Halogen light versus plasma arc light</td>
<td>70 (4.9)</td>
<td>12</td>
<td>No significant differences between both techniques.</td>
</tr>
<tr>
<td>Cacciafesta et al. 2004</td>
<td>b: 30</td>
<td>“split-mouth” with randomization</td>
<td>600</td>
<td>stainless steel</td>
<td>I, II, III</td>
<td>Halogen light versus plasma arc light</td>
<td>33 (5.5)</td>
<td>12</td>
<td>As above</td>
</tr>
<tr>
<td>Krishnaswamy et al. 2007</td>
<td>a: 30</td>
<td>“split-mouth” with randomization</td>
<td>544</td>
<td>stainless steel</td>
<td>I, II, III</td>
<td>Light-emitting diode (LED) lamp versus halogen light</td>
<td>41 (7.5)</td>
<td>15</td>
<td>As above</td>
</tr>
<tr>
<td>Elekdag-Turk et al. 2008</td>
<td>c: 37</td>
<td>“split-mouth” with randomization</td>
<td>672</td>
<td>metal</td>
<td>I, II</td>
<td>self-etching primer versus conventional</td>
<td>4 (0.6)</td>
<td>6</td>
<td>Improved bracket survival rate with self-etching primer than the conventional method.</td>
</tr>
<tr>
<td>Krishnaswamy et al. 2007</td>
<td>c: 37</td>
<td>“split-mouth” with randomization</td>
<td>600</td>
<td>nickel-titanium &amp; stainless steel</td>
<td>I, II, III</td>
<td>Light-emitting diode (LED) lamp versus halogen light</td>
<td>25 (4.20)</td>
<td>9</td>
<td>No significant differences between both techniques.</td>
</tr>
<tr>
<td>Varlik et al. 2009</td>
<td>a: 30</td>
<td>universal numbering system, odd-numbered teeth as control group, even-numbered teeth experimental group.</td>
<td>544</td>
<td>stainless steel</td>
<td>Mini Ovation</td>
<td>highly filled light-cured sealant (HFLCS) versus conventional adhesive</td>
<td>18 (3.3)</td>
<td>18</td>
<td>ProSeal can be used as a preventive measure without affecting the bonding properties of metal brackets.</td>
</tr>
<tr>
<td>Campoy et al. 2010</td>
<td>a: 46</td>
<td>prospective controlled clinical trial</td>
<td>531</td>
<td>Stainless steel</td>
<td>?</td>
<td>saliva contamination before bonding versus after bonding</td>
<td>37 (7.1)</td>
<td>6</td>
<td>Either before or after bonding, no significant increase in bracket detachment with saliva contamination.</td>
</tr>
<tr>
<td>Romano et al. 2012</td>
<td>a: 19</td>
<td>Age range 11-39</td>
<td>380</td>
<td>nickel-titanium</td>
<td>I, II, III</td>
<td>Conventional Transbond XT versus Transbond Plus Color Change (TPCC)</td>
<td>6 (1.6)</td>
<td>6</td>
<td>With both TXT or TPCC methods, a few brackets detached.</td>
</tr>
<tr>
<td>Romano et al. 2012b</td>
<td>a: 20</td>
<td>Age range 11-15</td>
<td>400</td>
<td>nickel-titanium</td>
<td>I, II, III</td>
<td>Fewer brackets failures with conventional Transbond XT and Transbond XT+TPSEP than Orthodontic Concise and Transbond XT without primer.</td>
<td>20 (5)</td>
<td>6</td>
<td>Fewer brackets failures with conventional Transbond XT and Transbond XT+TPSEP than Orthodontic Concise and Transbond XT without primer.</td>
</tr>
<tr>
<td>Hammad et al. 2013</td>
<td>a: 30</td>
<td>“split-mouth” with randomization</td>
<td>538</td>
<td>straight-wire</td>
<td>?</td>
<td>Conventional adhesive versus Amorphous calcium phosphate-containing adhesive</td>
<td>11 (2.04); 17 (3.1)</td>
<td>6</td>
<td>The ACP-containing adhesive seems to be an alternative to conventional adhesives.</td>
</tr>
<tr>
<td>Bovali et al. 2014</td>
<td>a: 64</td>
<td>Randomized controlled trial</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>Indirect vs direct bonding</td>
<td>17 (28.3)</td>
<td>6</td>
<td>Indirect bonding was statistically significantly faster than direct bonding. Both techniques showed similar risks of failure.</td>
</tr>
</tbody>
</table>
prospective cohort,\(^1\) one retrospective survey,\(^1\) and two studies did not report about the study design.\(^4,34\) Trials originated from the Netherland,\(^1\) Brazil,\(^4,34\) India,\(^20,38\) Turkey,\(^21,31,37\) Switzerland,\(^22\) Italy,\(^23,24,30\) Sweden,\(^27\) Greece,\(^32\) Spain,\(^33\) Egypt,\(^35\) and Korea.\(^36\) 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 353:495. In most of the included studies, patients were distributed as class I, II, and III malocclusion,\(^4,20,23,24,30-32,34,36\) and stainless steel brackets were used.\(^20,21,23,24,30,32,33,38\) In all the studies, the number of brackets used ranged from 361 to 3336. Four studies compared the halogen light technique with the other adhesive systems on brackets detachment after orthodontic bonding,\(^20,24,30,32\) while three studies compared direct versus indirect bonding techniques in relation to brackets detachment during orthodontic treatment.\(^22,23,38\)

**Methodological Quality:** Nine included studies\(^20,22,24,27,30-32,34\) had CMS score of 70% or above and six studies\(^21,22,25,33,35,37\) had CMS score of 60%. Only two studies\(^1,38\) had CMS score of 50%. Two of the studies provided the justification for sample size and provided information about drop outs from the study.\(^22,27\) None of the included studies reported the clinical importance of the results (Table-II). Risk of bias is presented as a graph in Figure 2. Almost all the included studies had a high risk of bias,\(^1,4,20-24,30-38\) while only one study had an unclear risk of bias.\(^27\)

**Incidence of Orthodontic Brackets Detachment:** The incidence of orthodontic brackets detachment ranged from 0.6 to 28.3% in the selected studies. The follow-up period after bonding of brackets ranged from 6 months to 22 months. The details are provided in Table-I. A 6-months detachment incidence was given in seven included studies (0.6% to 28.3%).\(^1,22,31,33-35,38\) One study reported 9-months incidence of 4.2%.\(^34\) Four studies reported 12-months incidence (3.1% to 5.7%).\(^24,30,35,36\) Two studies reported 15-months incidence (4.3% to 7.5%).\(^20,23\) Three studies reported 18-months incidence (2.5% to 4.2%).\(^1,21,27\) Only one study reported a 22-months incidence (2.6%).\(^37\)

**DISCUSSION**

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%),\(^22\) while others reported rela-
Orthodontic brackets detachment

Table II: Methodological quality assessment of included studies based on Coleman Methodology Scoring.\(^{28}\)

<table>
<thead>
<tr>
<th>Study</th>
<th>Criteria</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Score</th>
<th>Scores (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sfondrini et al. 2004(^{26})</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>7/10</td>
</tr>
<tr>
<td>Cacciafesta et al. 2004(^{24})</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>7/10</td>
</tr>
<tr>
<td>Krishnaswamy et al. 2007(^{20})</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>7/10</td>
</tr>
<tr>
<td>Elekdag-Turk et al. 2008(^{19})</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>7/10</td>
</tr>
<tr>
<td>Koupis et al. 2008(^{32})</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>7/10</td>
</tr>
<tr>
<td>Varlik et al. 2009(^{21})</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>6/10</td>
<td>60</td>
</tr>
<tr>
<td>Campoy et al. 2010(^{35})</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>6/10</td>
</tr>
<tr>
<td>ROMANO et al. 2012(^{4})</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>6/10</td>
</tr>
<tr>
<td>ROMANO et al. 2012b(^{34})</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>7/10</td>
</tr>
<tr>
<td>Hammad et al. 2013(^{36})</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>6/10</td>
</tr>
<tr>
<td>Bovali et al. 2014(^{22})</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>8/10</td>
</tr>
<tr>
<td>Jung 2014(^{37})</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>6/10</td>
</tr>
<tr>
<td>Menini et al. 2014(^{33})</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>7/10</td>
</tr>
<tr>
<td>Ozer et al. 2014(^{37})</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>6/10</td>
</tr>
<tr>
<td>Vijayakumar et al. 2014(^{38})</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>5/10</td>
</tr>
<tr>
<td>Bazargani et al. 2016(^{27})</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>9/10</td>
</tr>
<tr>
<td>Roelofs et al. 2017(^{1})</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>5/10</td>
</tr>
</tbody>
</table>

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 studies\(^{1,4,22,33,35-38}\) 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
Fig.1: Risk of bias summary: Authors’ judgments about each risk of bias item for each included study.

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.

Grant Support & Financial Disclosures: None.

REFERENCES