**Original Article**

**Bond Failure with a No-Mix Adhesive System**

*An 18-Month Clinical Review*

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**ABSTRACT**

**Objective:** To determine the bond failure pattern and time to first bond failure at an orthodontic clinic.

**Materials and Methods:** The study included 63 subjects meeting the study criteria. A total of 1074 brackets (Roth prescription 0.022 slot) were bonded to incisors, canines, and premolars using a no-mix adhesive (Unite, 3M Unitek). The survival and failure rates of the brackets were evaluated by tooth position in the dental arch, sagittal occlusal relationship, and gender of the patients. Overall bracket survival rates were estimated using the Kaplan-Meier test.

**Results:** The total percentage of bond failure was 17.87%. The mean survival time for the sample was 235 days (SE = 32.27 days). Significantly higher failure rates were observed for posterior than anterior teeth (*P* < .05) and in the Class II division 2 malocclusion group than other malocclusion groups (*P* < .05). No difference was observed between dental arches or genders. However, in terms of survival time, the difference was marginally significant for gender (*P* = .051)

**Conclusion:** For 1074 brackets bonded with a no-mix adhesive system in 63 patients, the mean time until first bracket failure was 235 days. The overall failure rate of brackets was 17.87%.

**KEY WORDS:** Bond failure; No-mix adhesive; Bracket failure

**INTRODUCTION**

Orthodontic treatment usually requires three-dimensional control of teeth, for which the use of fixed appliances becomes imperative. These appliances incorporate attachments, are bonded directly to the tooth surface, and should survive until the end of active treatment. However, some bonds will fail in service. Previously, it was thought that increasing the mean bond strength would lead to a reduction in the bond failure rate, but recently, this causal link has been challenged. For example, a bonding system with a high mean bond strength and a wide variation in bond strength might have a greater likelihood of failing than a system with a lower mean bond strength but a closer distribution about that mean.

Many different bonding systems have been developed, such as two-paste systems, no-mix adhesives, conventional glass ionomers, resin-modified glass ionomers, and polyacid-modified resin composites (compomers). Some of these new bonding systems are also light activated. From a clinical point of view, the success of bonding is of major importance. The frequency of bond failure and the specific sites in the dentition have therefore attracted much interest. A review of the most recent literature about bonding shows that the large variations in the success rate depend on the bonding agent employed, bonding technique used, etching time, concentration of the etch, or characteristics of the bracket base. Operator and patient factors are also likely to influence the failure rate of any bonding system. Care in the clinical technique, moisture control, choice of bonding material, and appliance fitted along with instructions given to the patient are all controlled by the operator, whereas gender and age of the patient, the presenting malocclusion, and care taken of the appliance are patient variables.

The purpose of this study was to assess the time to first bond failure of stainless-steel orthodontic brackets bonded with a no-mix adhesive system and investigate...
further the frequency and identify the factors that contribute to the bond failure rate of brackets. The effect of patient gender on bracket survival time was also assessed.

MATERIALS AND METHODS

The data for this longitudinal study were obtained from the orthodontic files of patients who started orthodontic treatment at a tertiary care hospital from June 2002 to December 2003. The inclusion criteria were patients having orthodontic attachment bonded to the facial surface of at least the upper and lower incisors, brackets bonded by the principal clinician, and treatment duration of at least 18 months. The exclusion criteria were patients with rebonded brackets, continued or follow-up cases, and cases requiring growth modification with functional appliances.

The following information was recorded for each patient: age, gender, class of presenting malocclusion, date of placement of bonded orthodontic brackets, and the fate of each bracket until December 2005. If the bond failure occurred but the patient was unaware of it, the date of the follow-up visit when the failure was noted was recorded.

Table 1. Sample Characteristics of 1074 Brackets Bonded with the No-Mix Adhesive System

<table>
<thead>
<tr>
<th>No. of patients</th>
<th>63</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age at start of treatment, y</td>
<td>14.4</td>
</tr>
<tr>
<td>No. of bonded brackets</td>
<td>1074</td>
</tr>
<tr>
<td>Total bracket failures</td>
<td>192</td>
</tr>
<tr>
<td>Bond failure, %</td>
<td>17.87</td>
</tr>
<tr>
<td>Mean survival time (SE), d</td>
<td>235 (32.27)</td>
</tr>
</tbody>
</table>

The study consisted of 63 patients (20 males and 43 females) meeting the study criteria. The mean age at the start of treatment was 14.4 years. A total of 1074 brackets were bonded to incisors, canines, and premolars. The bracket type used was the Roth prescription 0.022 slot (Ortho Organizers, San Marcos, Calif). The brackets were bonded with a no-mix adhesive (Unite, 3M Unitek, Monrovia, Calif) according to the standard bonding procedure.

Overall and groupwise mean survival time (MST) with standard errors (SE) were computed, and the differences for gender and class of malocclusion were tested by log-rank test. Graphs of overall survival time including that by gender were depicted. A $\chi^2$ test was used to compare the proportion of bond failure in different groups.

RESULTS

The sample characteristics of the study population are given in Table 1. The total percentage of bond failure was 17.87%. The MST for the sample was 235 days (SE = 32.27 days; Figure 1).

The failure rate was lower for brackets bonded in the maxillary than the mandibular arch, but this inter-arch difference was statistically insignificant ($\chi^2 = 3.13$, $df = 1$, $P = .076$). The MST was 431 days for maxillary brackets and 313 days for mandibular brackets (Table 2).

Bond failure rates were significantly higher for teeth bonded in the posterior segments than for those bonded in the anterior segments ($\chi^2 = 20.88$, $df = 1$, $P < .0001$), along with a higher MST (379 days) for the posterior teeth than anterior teeth (MST = 362 days; Table 3).
DISCUSSION

The results from this clinical bond study confirmed that the pattern of orthodontic bond failure in vivo was not uniform across all teeth in either dental arch. These bond failures occurred even though all teeth were bonded by the same operator using the same adhesive and a standardized protocol. It appears that certain sites in the mouth have a greater predilection for failure than others.

The failure rates were significantly higher for teeth bonded in the posterior segments (premolars) than for those bonded in the anterior segments (incisors and canines), reinforcing the pattern of higher bond failures in the posterior segment as reported by other studies.²,⁵,⁸ This may be due to the altered topography of the buccal enamel in these teeth.⁹-¹² Other factors could be the difficulty in moisture control during bonding in the posterior segments, heavier masticatory forces, and partial eruption of second premolars. The MSTs were comparable for both anterior and posterior segments, which is contrary to other studies, in which the MST was higher in the anterior than posterior teeth.¹³

In this study, there was no significant difference in bond failure rates between the upper and lower dental arches. This is in agreement with previous clinical studies,¹,¹₄-¹⁶ although in some other studies, more failures were reported in the lower arch.²,¹⁷-¹⁹ This could be attributed to the difficulty of moisture control in the lower arch as well as to the occlusal forces¹ having a more pronounced effect on the lower teeth. In our study, clearance for bonding of the lower teeth was obtained temporarily by the use of bonding adhesive on the lower molars (preferably deciduous molars) to raise the bite, whereas Sunna and Rock¹ used a maxillary bite plate that made it possible to open the bite and prevent interference with the bracket placement in the lower arch. This is in agreement with the practice that occlusal interferences increase bond failure rates in the mandible. In addition, bond failure occurred earlier in the lower arch as confirmed by a lower MST, which conforms to the results of others.²,¹⁸,¹⁹

There was no significant difference between males and females in terms of failure rate. This is in agreement with findings of Kinch et al⁶ but is inconsistent with those of Millet and Gordon.³ In addition, a higher, marginally significant MST seen for females may indicate their cautious approach, particularly in the early phases of treatment, as females appear to be more careful and more motivated for esthetic improvement than their male counterparts.

When different malocclusion groups were considered, there was no significant difference between type of malocclusion and bracket survival time. In addition, patients presenting with a Class II division 2 occlusion had a significantly higher bond failure rate when compared to other groups. This is consistent with the findings of Millet et al,²⁰ who also reported higher failure rates for Class II division 2 malocclusion and observed

No significant difference was found between the proportion of bond failing within genders (χ² = 0.05, df = 1, P = .815). However, males (MST = 139 days) had an earlier bracket failure time compared to females (MST = 279 days; log-rank test, P = .051; Table 4, Figure 2).

In terms of malocclusion, Class II division 2 cases exhibited significantly higher frequency of bond failures (Table 5; χ² = 12.48, df = 3, P = .005). However, in terms of survival time (in days), no significant difference was observed among various type of malocclusion (log-rank test, P = .503).

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no significant difference between type of malocclusion and bracket survival time. However, this study differs from our study with respect to use of different bonding systems (light-cured adhesive vs no-mix adhesive in our study); therefore, the results should be compared with caution.

In the present study, the mean survival time of brackets bonded with a no-mix adhesive system was 235 days, or almost 8 months, as opposed to 15 to 18 months seen in other studies. Most fixed-appliance therapy lasts about 18 to 24 months, and the closer the MST is to this, the lower the bond failure rate is expected to be.

Therefore, it is important to outline factors that may have contributed to a low MST as confirmed by a high bond failure rate (17.87%), which was higher than in other studies in which a no-mix system was used (<10%) and lower than in studies in which a light-cured system was used (20%). This overall high rate of bond failure can be attributed to a number of factors. Operator errors resulting in early bond failure include inadequate etching and poor moisture control. Interestingly, on comparison with other studies, an increased failure rate along with a lower MST recorded for the anterior teeth in our study possibly highlights the inadequacy of our patient population to follow proper dietary instructions and care for their brackets since operator errors are considered to be reduced in bonding anterior brackets. Some of the limitations that were drawn from this study were a small sample size and increased sample variability, which accounts for an increase in the standard error of the mean observed for our study.

CONCLUSIONS

- For 1074 brackets bonded with a no-mix adhesive system in 63 patients, the mean time until first bracket failure was 235 days.
- The overall failure rate of brackets was 17.87%.

REFERENCES