Original Article

Failure Rate of Self-ligating and Edgewise Brackets Bonded with Conventional Acid Etching and a Self-etching Primer: *A Prospective In Vivo Study*

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Abstract: The purpose of this study was to comparatively assess the failure rate of self-ligating and edgewise brackets bonded with a self-etching adhesive and conventional phosphoric acid in patients followed for 12 months of active treatment. Sixty-two patients with complete permanent dentitions, similar treatment plans, and mechanotherapy were selected for the study. GAC Microarch edgewise brackets and ORMCO Damon2 brackets were bonded using a split mouth design, using the 3M Transbond Plus Self-etching primer (SEP) and Transbond XT paste; and conventional acid etching, with Orthosolo primer and Enlight paste, applied at an alternate sequence so that the adhesives were equally distributed on the maxillary and mandibular right and left quadrants. Data analysis was conducted with the use of logistic regression modeling. No difference in failure incidence was noted for either bracket-adhesive and mandibular or maxillary arch combinations, whereas a statistically significant difference was shown for right-sided appliances. On the basis of the results of this study, bonding of self-ligating brackets with SEP does not demonstrate higher probability for failure relative to standard bonding procedures and conventional brackets. (*Angle Orthod* 2006;76:119–122.)

Key Words: Self-ligating; Self-etching primer; Failure rate

INTRODUCTION

Self-etching primers (SEP) have been introduced in orthodontics to shorten and simplify the bonding procedure, and despite the fact that they have only recently been introduced in the profession, 20% of practitioners in the United States routinely use them.[1]

A number of studies[2–4] have shown the application and investigated the performance of these materials. Research in the associated field of restorative dentistry has shown that the use of SEP produces a less-defined enamel-etching pattern compared with that resulting from the conventional acid-etching technique.[5] However, no direct correlation between a specific etching pattern and bond strength has been identified,[6] and the bond strength found for SEP is comparable with the values obtained using conventional enamel acid etching.[7]

The orthodontic literature lists a limited number of studies examining the bond strength or in vivo failure rate of SEP. Laboratory studies have shown no statistically significant difference in the shear bond strength between conventional acid etching and SEP,[8] whereas SEP demonstrated higher shear bond strength compared with conventional etching.[9] Laboratory assessments of bond strength, however, present substantial variability because of several variables arising from the selection of teeth, standardization of experimental configuration, and obscure clinical relevance of results, and thus, their usefulness has not been unequivocally defined.[10–11] Thus, despite the increased interest and number of studies published on this issue, there is a scarcity of evidence concerning the comparative performance of SEP in vivo.[12–14]

Similarly, very limited information is available on the

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TABLE 1. Descriptive Statistics and Statistical Analysis of Failure Incidence by Treatment Type and Tooth Type[a]

						Univariate Analysis[b]		Multivariate Analysis[b]	
		N	Success	Failure	Failure Incidence	Relative Risk	*P* Value	Adjusted Relative Risk	*P* Value
Bracket	Damon	849	830	19	0.022	Reference		Reference	
	Microarch	371	360	11	0.029	1.32	NS	1.33	NS
Adhesive	Ormco	610	596	14	0.022	Reference		Reference	
	3M	610	594	16	0.026	1.14	NS	1.15	NS
Arch	Maxilla	608	595	13	0.021	Reference		Reference	
	Mandible	612	595	17	0.027	1.29	NS	1.30	NS
Side	Left	605	599	6	0.009	Reference		Reference	
	Right	615	591	24	0.039	3.93	$<.05$	4.05	$<.05$
Total		1220	1190	30	0.025				

[a] NS indicates nonsignificant.
[b] Based on logistic regression modeling, dependent variable: treatment outcome (reference category: success).

clinical failure rates of self-ligating brackets, which have also become common in orthodontics.

The hypotheses tested in this study were that (1) SEP show increased failure rates and (2) self-ligating brackets demonstrate higher failure rates relative to conventional, edgewise brackets. Therefore, the purpose of this study was to comparatively assess the clinical failure rate of self-ligating and edgewise brackets bonded with an SEP and conventional acid-etching technique over a 12-month treatment period.

MATERIALS AND METHODS

Thirty-nine females and 23 males (mean age 14 years; range 13–16 years) were selected for the study on the basis of the following criteria: complete permanent dentition, nonextraction treatment, absence of buccal restorations, and similarity in the projected mechanotherapy (no intermaxillary elastics, headgears, or other auxiliaries).

A total of 371, 0.022-inch slot, edgewise brackets (Microarch, GAC, Bohemia, NY) were bonded on 13 female and six male patients. A total of 184 brackets were bonded with Transbond Plus SEP and Transbond XT paste (3M/Unitek, Calif) and 187 with Orthosolo primer and Enlight paste (ORMCO, Glendora, Calif).

Similarly, a total of 849 Damon2 brackets (ORMCO) were bonded on 26 female and 17 male patients (426 with Transbond Plus and Tranbond XT and 423 with Orthosolo and Enlight).

The teeth were pumiced and rinsed, and extra care was taken to remove any calculus that was present. This is considered an important step because with the use of SEP, it is impossible to visibly detect the chalky enamel appearance, as in the traditional acid-etching method, and thus no empirical estimate of the etching efficacy is available.

Bonding involved a split mouth design and, for every participating patient, the quadrants assigned to each adhesive were consequently alternated so that these were distributed equally to the left and right sides. The materials were applied according to the manufacturer's instructions. Polymerization was initiated with a plasma light source (Ortholux, 3M Unitek, St Paul, Minn) operated in the following manner: each bond was irradiated for three seconds from the gingival, three seconds from the occlusal, and three seconds interproximally. The curing light output was checked on a regular basis to ensure potential fluctuations in output intensity. All quadrants were bonded in the same manner.

The initial wire, placed in all cases immediately after bonding, was 0.016-inch NiTi for the Microarch brackets and 0.014-inch NiTi for the Damon2 brackets, followed by various combinations of round and rectangular NiTi and stainless steel wires as treatment progressed. The observation period was 12 months, and the recording of failed brackets involved only first-time failures. All bonding and clinical procedures were performed by the first author.

The statistical analysis of the results included descriptive statistics as well as univariate and multivariate statistical analysis to explore the effect of treatment type or tooth type (or both) on failure, using logistic regression modeling.[15] Treatment outcome (success/failure) constituted the dichotomous-dependent variable, where bracket type (edgewise vs self-ligating), adhesive (Transbond XT vs Enlight), dental arch (maxillary vs mandibular), and side (right vs left) were investigated as independent variables in the models separately in the univariate and simultaneously in the multivariate models.

RESULTS

Table 1 depicts the incidence of bracket failure over the 12-month observation period. No statistical differ-

ence was found for the failure rate of self-ligating vs conventional bracket and between the two bonding modes used. Also, no difference was identified between maxillary and mandibular arch, whereas right-sided brackets showed fourfold probability of failure in both univariate and multivariate analyses.

DISCUSSION

The results of this study indicate that the use of SEP, in combination with a self-ligating bracket, does not show a significantly higher incidence of failure compared with the standard appliances and conventional acid etching.

The failure rates observed for the Transbond Plus are comparable with previous studies,[9] that followed fewer bonds for a shorter period, in which most cases did not exceed six months.[12] A long-term study on a similar sample size reported 0.89% failure rate over a 14-month period for the Transbond Plus SEP.[14] In contrast to the results of the above studies, Ireland et al[13] have found a 10.99% failure rate with Transbond Plus relative to a 4.95% with the conventional acid etching over a six-month period. It must be noted that studies using conventional acid etching have reported failure rates in the order of 7–8%.[16]

The use of SEP with the Transbond paste was chosen because reports in the literature have indicated that there might be a compatibility problem with the SEP and pastes. Combining SEP from other manufacturers resulted in a ninefold increase in the failure rate.[14]

Despite the thicker profile of the self-ligating bracket (2.30 vs 1.86 mm), no statistical difference was shown between their failure frequencies in the posterior segments of the arches. Thus, whereas a concern has been expressed on the potential implication of increased bracket thickness on the formation of large debonding moments especially on the posterior segments of the mandibular arch,[17] it seems that the thickness of the self-ligating appliance is below the value required for the moment to have a measurable debonding effect.

The distribution and arch location of failures have also shown a considerable variation. Sunna[18] found no statistically significant difference on failure rates between jaws, whereas other studies using conventional bonding have found more failures on the mandible,[19] as also shown in this study.

In general, clinical bond failure studies have increased in popularity because of their profound clinical relevance assigned to the fact that the examined variable is the actual survival of bonds. However, this type of protocol is very demanding from a setup perspective because it is laborious, requires extended monitoring, and, therefore, it is difficult to apply in an ordinary practice setup. The large clinical environments, such as those found in educational institutions, present some unfavorable effects. These include such unfavorable factors as the intervention of multiple operators, the socioeconomic and dental status of patients, which may not be random and act as a confounding variable, nonrandomized variation in selection of malocclusions, and associated mechanotherapy including the use of interarch elastics and space closure with chains, among others. Thus, several exclusion criteria must be considered to avoid cross-effects from various participant-related parameters such as habits, masticatory forces that vary with facial type, and diet.

There are also several operator-induced parameters, which should be ruled out, including mechanics, handling of materials, and bonding procedures. This study involved the monitoring of sample by the same clinician to exclude interexaminer variability, whereas the population was followed for a minimum of 12 months to increase the clinical relevance of the findings to extended period of treatment.

The finding that right-sided brackets demonstrated a higher incidence of failures compared with their left-sided counterparts may be assigned to masticatory habits. In general, differences in failure rates have been noted between males and females,[20] possibly attributed to the higher masticatory forces of the former, as well as between different populations for identical materials. This effect implies that culturally influenced dietary habits and sex differences may affect the failure rate of brackets in vivo.

The use of plasma lamps further shortens the duration of the bonding process, and as such, it is a useful adjunct in SEP application.[21] However, the effect of primers on the degree of cure of adhesive and their biocompatibility remains unknown. Handling of these materials must be performed with caution because the acidic nature of the primer and associated lack of rinsing may cause irritation of the oral mucosa. In addition, no information is available on the potential of reaction of these acidic primers with the calcium of the etched enamel surface to form calcium phosphate complexes, thus affecting the solubility of the primer.[22] Therefore, several physical properties of these primers should be established before they are routinely applied on a wide scale.

CONCLUSIONS

- No difference in failure incidence was noted between self-ligating and edgewise brackets bonded with conventional acid etching or SEP in the mandibular or maxillary arches, whereas a statistically significant difference was shown for right-sided appliances. It

seems that bonding self-ligating brackets with SEP did not demonstrate a higher probability for failure relative to standard bonding procedures and conventional brackets.

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