A Study comparing Right On/acid etch, with 4-META/air abrasion for orthodontic bonding.

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Introduction

A new orthodontic bonding material (4-META, Sun Medical) has been proven to provide good bond strength. In addition to a high bond strength 4-META also leaves a low residue on the tooth surface following de-bonding (Clark 1999 MSc thesis University of Newcastle), thus aiding the clean up. However the use of acid etching as a surface preparation can produce excessive bond strengths in the laboratory.

Objective

To compare a novel enamel surface preparation (air abrasion) in conjunction with an adhesive promoter (4-META) against Right On with acid etch enamel preparation.

Design and setting

An in-vitro study comparing shear peel characteristics of Right On with acid etch surface preparation against 4-META with air abrasion surface preparation

Materials and methods

81 intact, caries free, premolar teeth were collected locally and stored in accordance with ISO (1994). The teeth were lightly pumiced to remove any surface debris, then subsequently divided up into four test groups (an equal distribution of uppers and lowers with the exception of one additional upper tooth in group 4 i.e. n=21:

1. Group one: Right On, acid-etch (control), n=20.
2. Group two: 4-META 1 s air abrasion, n=20.

Surface preparation comprised of 37% phosphoric acid in the control and air abrasion abrasion particles 50 μm, at a distance of 10mm for the allocated time in each of the test groups. The working air pressure was 60 psi for the air abrasion unit. Following the surface preparations, corresponding upper and lower brackets with surface areas of 14.932±0.21mm² and 15.26±0.15mm² respectively, were applied to the teeth in accordance with manufacturer’s instructions. Following storage at 37°C and 100% humidity for 24h, each group was subjected to shear peel testing using an Instron testing apparatus as described by Fox et al BJO 1994; 21:33-43.

Results and analysis

Figure 1. Shows a graph of probability of failure against stress. The lines indicate the best least-squares fit to the Weibull distribution.

Table 1. Shows mean bond strengths and probability of failure (Pf) at a given stress.

<table>
<thead>
<tr>
<th>Stress (MPa)</th>
<th>gp 1</th>
<th>gp 2</th>
<th>gp 3</th>
<th>gp 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPa (SD)*</td>
<td>6.1</td>
<td>2.5</td>
<td>9.8</td>
<td>13.0</td>
</tr>
<tr>
<td>Pf at 5 MPa</td>
<td>32%</td>
<td>79%</td>
<td>12%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Pf at 10 MPa</td>
<td>93%</td>
<td>87%</td>
<td>47%</td>
<td>14%</td>
</tr>
</tbody>
</table>

Table 1: Mean bond strength MPa (SD) and Probability of failure (Pf) at 5 MPa and 10 MPa:

* Mean values with the same letter are not significantly different (p>0.05) one way ANOVA.

Discussion

The storage method, materials and testing followed well established criteria as described by Fox et al. BJO 1994. The single paste resin adhesive, Right On was chosen as the control due to its ability for the monomer to diffuse into the enamel surface. The probability of bond failure (Pf) derived from Weibull equation, at 5 MPa for Right On was 32%. This figure is comparable to that found by Brown et al 2001, BOC abstract, but lower than that reported by Clark 1999 MSc thesis. However, a bond strength of between 6-8 MPa in vitro is considered acceptable clinically according to Reynolds Br dent J 1975; 2:171-178. Interesently, the probability of failure (Pf) derived from Weibull equation, at 5 MPa for Right On was 32%. This figure concurs with earlier work by the author, but is higher than that reported by Clark. Sargison et al BJO 1999; 26: 141-146 reported air abrasion in conjunction with Right On as unsuitable for clinical use. Sargison et al BJO 1999; 26: 141-146 found that the enamel surface following air abrasion was of uniform roughness, comparable to that of etched enamel. This uniform roughness does not appear to be affected by tooth type or enamel surface variations, Clark 1999. In addition, air abrasion reduces the time required for surface preparation. The use of air abrasion with 4-META not only reduces the time required to prepare the enamel surface but it also reduces the high bond strengths seen with acid etch surface preparation which may lead to enamel surface damage at debond.

The air abrasion system operated at 60 psi and at a distance of 10mm achieved by using a spacer that also acted as a collimator. The particle size used was 50 μm. Waveren Hogervorst AJO DFO 1988; 94:222-230, found that an equivalent amount of enamel was lost using a particle size identical to the above at a working pressure of 15 psi for 1 s at a distance of 1 mm. Although he found that the amount of enamel loss increased with time and pressure, distance was not a variable considered.

The mean bond strengths of the 4-META 3 s and 10 s were significantly higher than the control. Hotta et al Dent Mater 1992: 8:173-175, suggested the reason for increased bond strengths achieved with 4-META was due to an enhanced ability for the monomer to diffuse into the enamel surface. The probability of failure (Pf) derived from Weibull equation, at 5 MPa for the 3 s and 10 s group was significantly lower than that of the control. At 10 MPa 93% of the control group would be expected to fail, but a mere 14% in the ten second air abrasion group.

Waveren Hogervorst AJO DFO 1988; 94:222-230 voiced concerns about the potential hazards associated with aluminium oxide scatter. In this study it was observed that the spacer applied to the tip seemed to collimate the abrasion particles. Also, combining water with the air abrasion system produced an aerosol, this had the effect of greatly reducing the amount of scatter. We would suggest that these two factors should also be given consideration when developing protocols aimed at achieving safe consistent results using air abrasion.

Conclusions

- The use of 4-META with air abrasion for 3 s and 10 s resulted in a higher mean bond strength than the Right-on control.
- 4-META with air abrasion in the 3 s and 10 s groups had a lower probability of failure than Right-on at 5 MPa and 10 MPa.