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Effect of air-blowing duration on the bond strength of current one-step adhesives to dentin

Jiale Fu[a,*], *Pipop Saikaew*[b], *Shimpei Kawano*[c], *Ricardo M. Carvalho*[d], *Matthias Hannig*[e], *Hidehiko Sano*[c], *Denis Selimovic*[c]

[a] *General Dentistry, Department of Endodontics, School and Hospital of Stomatology, China Medical University, No. 117 Nanjing Street, Heping District, 110002 Shenyang, Liaoning Province, China*
[b] *Department of Operative Dentistry and Endodontics, Faculty of Dentistry, Mahidol University, No. 6, Yothi Road, Ratchathewi District, Bangkok 10400, Thailand*
[c] *Department of Restorative Dentistry, Division of Oral Health Science, Hokkaido University, Graduate School of Dental Medicine, Kita 13, Nishi 7, Kita-ku, Sapporo 060-8586, Japan*
[d] *Department of Oral Biological and Medical Sciences, Division of Biomaterials, Faculty of Dentistry, University of British Columbia, Vancouver, BC V6T 1Z3, Canada*
[e] *Clinic of Operative Dentistry, Periodontology and Preventive Dentistry, Saarland University, Homburg, Saar, Germany*

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ABSTRACT

Objectives. To evaluate the influence of different air-blowing durations on the micro-tensile bond strength (μTBS) of five current one-step adhesive systems to dentin.

Methods. One hundred and five caries-free human molars and five current one-step adhesive systems were used: ABU (All Bond Universal, Bisco, Inc.), CUB (CLEARFIL™ Universal Bond, Kuraray), GPB (G-Premio BOND, GC), OBA (OptiBond All-in-one, Kerr) and SBU (Scotchbond Universal, 3M ESPE). The adhesives were applied to 600 SiC paper-flat dentin surfaces according to each manufacturer's instructions and were air-dried with standard, oil-free air pressure of 0.25 MPa for either 0 s, 5 s, 15 s or 30 s before light-curing. Bond strength to dentin was determined by using μTBS test after 24 h of water storage. The fracture pattern on the dentin surface was analyzed by SEM. The resin–dentin interface of untested specimens was visualized by panoramic SEM image. Data from μTBS were analyzed using two-way ANOVA (adhesive vs. air-blowing time), and Games-Howell (a = 0.05).

Results. Two-way ANOVA revealed a significant effect of materials (p = 0.000) and air-blowing time (p = 0.000) on bond strength to dentin. The interaction between factors was also significantly different (p = 0.000). Maximum bond strength for each system were recorded, OBA/15 s (76.34 ± 19.15 MPa), SBU/15 s (75.18 ± 12.83 MPa), CUB/15 s (68.23 ± 16.36 MPa), GPB/30 s (55.82 ± 12.99 MPa) and ABU/15 s (44.75 ± 8.95 MPa). The maximum bond strength of OBA and SUB were significantly higher than that of GPB and ABU (p < 0.05).

Significance. The bond strength of the current one-step adhesive systems is material-dependent (p = 0.000), and was influenced by air-blowing duration (p = 0.000). For the current

* *Corresponding author.*
E-mail address: fullers@126.com (J. Fu).
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one-step adhesive systems, higher bond strengths could be achieved with prolonged air-blowing duration between 15–30 s.

1. Introduction

One step self-etching systems, so-called ‘all-in-one’ system, have been initially advocated about 15 years ago [1]. They became increasingly popular and widely accepted for their distinguishing features; such as, handling convenience, time-saving and user-friendly properties [2]. However, it has been reported that the bond strength of 1-step self-etching systems is lower than that of 2-step and 3-step systems [3,4]. It appears that the simplified procedures of 1-step self-etching systems did not reduce the technique sensitivity of all-in-one systems, especially considering the air-blowing step [3–7].

Adhesive technology is continuously evolving by frequent replacement of commercial adhesive formulations [8]. Currently, as a new branch of 1-step self-etching system, the so-called ‘Universal System’ or ‘Multi-purpose System’ has become commercially available and regains attention from dental clinicians as ‘the eighth generation’ system [9]. These latest systems could not only be used in direct and indirect treatments following manufacturer’s instruction [9,10], but also seem to be adequate after short-term clinical evaluation [11,12] and medium-term clinical evaluation [13–15]. Taken together the mentioned advantages, universal systems might be a potential brand-new choice for the dentists in daily operative treatment.

In some of the current commercially available universal systems [10,11,16], 10-MDP is included as functional monomer, which has been mainly used as an etching monomer and proven very successful in promoting chemical adhesion to tooth tissue [17]. In previous studies, there were not so many 10-MDP containing 1-step self-etching systems included [2–5], because 10-MDP was originally synthesized and patented by Kuraray (Osaka, Japan) and hence was not widely available in the dental market [10–12,17].

Currently, an increased number of new systems, the so called ‘eighth generation’ adhesive system, have a common feature that they are prone to select 10-MDP as their functional monomer, but differ on application procedures, such as: coating manner, waiting time and air-blowing pressure. To ensure the ideal bonding performance could be achieved, detailed information on direction should not be overlooked. In previous studies, it was investigated that bond strength could be influenced by both of air-blowing duration [5] and pressure [18], because the information on applying process was indefinite in some 1-step self-etching systems’ instruction.

Based on different chemical compositions, universal systems required differently on application process. So far, the influence of different air-blowing durations on bond strength of universal systems has barely been investigated. The aim of this study was to evaluate the influence of different air-blowing durations on μTBS of current one-step adhesive systems. The null hypothesis tested in the present study was that the bonding performance of current one-step adhesive systems is not affected by air-blowing duration.

2. Materials and methods

2.1. Teeth used

One hundred extracted caries-free human molars were used in this study to test 5 different current one-step adhesive systems. Each set consists of 20 teeth, which were further divided into 4 groups with 5 teeth in each. The teeth were collected under a protocol reviewed and approved by the institutional review board of China Medical University, Shenyang, China. The teeth were stored at 4 °C in an aqueous solution of 0.5% Chloramine-T and used within 3 months after extraction. Flat dentin surfaces were obtained by removing the coronal enamel of each tooth in a gypsum model trimmer with water coolant, leaving the surrounding enamel. After that, the dentin surfaces were ground with 600-grit SiC paper for 60 s under continuous water-cooling to produce a standardized smear layer prior to bonding.

2.2. Adhesives

Five commercially available current one-step adhesive systems were applied in this experiment: ABU (All Bond Universal, Bisco, Inc.), CUB (CLEARFIL™ Universal Bond, Kuraray), GPB (G-Premio BOND, GC), OBA (OptiBond All-in-one, Kerr) and SBU (Scotchbond Universal, 3M ESPE). Table 1 shows the chemical compositions and the respective manufacturer’s instructions for application of these 5 adhesives. Among these systems, only OBA does not contain 10-MDP, OBA was selected as a control group from former all-in-one systems. The adhesive procedures in the present study, except for the air-blowing duration, followed the respective manufacturer’s application guide. Dentin surface in the 4 subgroups consisting of 5 teeth per adhesive were air-blown for either 0 s, 5 s, 15 s, or 30 s, respectively, before light-curing. The maximum air-blowing pressure was adjusted to be 0.25 MPa, and the air syringe head was positioned vertically to the dentin surface at a distance of 15 mm. All systems selected in the present study were applied only as one-step self-etch materials. The same operator performed all steps.

All bonded surfaces were built-up with resin composite (Clearfil AP-X, Kuraray Medical Inc.; Okayama Japan, Shade A3, Lots: BH0052) in increments to a thickness of 5 mm. Each incremental layer was light cured (PENCURE 2000, J. MORITA MFG. CROP) for 20 s, the light output intensity was properly controlled to be more than 2000 mW/cm^2. The bonded teeth were stored in distilled water at 37 °C for 24 h.