Does gradual dehydration affect the mechanical properties and bonding outcome of adhesives to dentin? [an abstract of dissertation and a summary of dissertation review]

CHOWDHURY, ABU FAEM MOHAMMAD ALMAS

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Chowdhury_AFMA_abstract.pdf (論文内容の要旨)
Does gradual dehydration affect the mechanical properties and bonding outcome of adhesives to dentin?

This study evaluated the effects of gradual dehydration on the Hardness (H) and Elastic Modulus (E) of adhesives and dentin, and on the Microtensile Bond Strength (μTBS) of adhesives to dentin.

The study was approved by the Hokkaido University Ethical Committee (# 2013-7). All teeth were collected after the patient’s informed consent. Twenty five sound human third molars were stored in an aqueous solution of 0.5% Chloramine-T at 4°C and used within 6 months of extraction. For μTBS test, flat, occlusal dentin surfaces of twenty third molars were exposed and subsequently polished with 600-grit SiC paper (Sankyo-Rikagaku Co., Saitama, Japan) under running water for 60 s. They were then randomly divided into four groups (n = 5): Clearfil Mega Bond Wet (MBW), Clearfil Mega Bond Dry (MBD), Clearfil SE Bond 2 Wet (SE2W) and Clearfil SE Bond 2 Dry (SE2D). Adhesives were applied according to the manufacturer’s instruction and light cured (Optilux 401, Demetron/Kerr, Orange, CA, USA) at ≥550 mW/cm². Following composite resin (Clearfil AP-X, Kuraray Co, Ltd, Osaka, Japan) build-up, the specimens were stored in distilled water at 37°C for 24 h. Resin/dentin beams (cross-sectional area: 1 mm²) were prepared by a low-speed diamond saw (IsoMet 1000, Buehler, Lake Bluff, IL, USA) and a total of 15 beams per group were randomly selected and tested. A pilot study established that it takes approximately 3 min to remove each bonded beam from the storage medium, wipe off water, measure the cross-sectional area and attach to the Ciucci’s jig with a cyanoacrylate adhesive (Model Repair II Pink, Dentsply-Sankin, Tokyo, Japan). In the wet groups (MBW and SE2W), each beam was tested 2 min after fixing to the grips of the testing device to allow adequate setting of the cyanoacrylate adhesive to prevent glue failure. During this period, a small piece of wet paper (Kimwipe S-200, Nippon paper Crecia Co., Tokyo, Japan) was used to cover the beams. In the dry groups (MBD and SE2D), each beam was kept on the bench for 7 min after fixing to the jig without wet paper covering. Therefore, the wet group was tested at 5 min after removal from the storage medium and the beams were kept wet until tested; and the dry group was tested at 10 min after removal from the distilled water and underwent free dehydration during this period. All tests were conducted at room conditions (23°C and 30% RH). The μTBS test was carried out at a crosshead speed of 1 mm/min (EZ-S, Shimadzu Co., Kyoto, Japan) until failure occurred. The data were analyzed by two-way ANOVA to demonstrate the effects of adhesive and condition (dry vs. wet), followed by Tukey’s test at 5% level of significance. The fractured specimens were coated with Pt-Pd (E-1030, Hitachi, Tokyo, Japan), and were observed using a field emission scanning electron microscope (FE-SEM; S-4000, Hitachi, Tokyo, Japan) at an accelerating voltage of 10kV. Failure modes were categorized as: A, Adhesive failure; CD, Cohesive failure in dentin; CC, Cohesive failure in composite; M, Mixed failure.

Five dentin slabs (1 per tooth; approximately 11 mm x 1.5 mm) were prepared (IsoMet 1000, Buehler, Lake Bluff, IL, USA) and then sequentially finished with no. 1000, 1200, and 2000-
outcomes and should be avoided as a significant source of test variation.

Gradual dehydration of μTBS testing specimens can cause significant change in baseline (5 min), for MB discs at 20 min (p < 0.001) and SE2 discs (p = 6.004; p < 0.05) values, where H became significantly different at 1 h (p < 0.05). However, for E, the difference became significant at 24 h (p < 0.05). In case of dentin, gradual dehydration only caused significant differences between mean H (F = 11.260; p < 0.001) values which became significantly different at 24 h (p < 0.05).

Gradual dehydration caused significant differences between mean weight values of dentin beams (F = 15.807; p < 0.001), MB discs (F = 160.977; p < 0.001) and SE2 discs (F = 193.627; p < 0.001). For dentin, the difference became significant at 10 min (p < 0.001) from the baseline (5 min), for MB discs at 20 min (p < 0.05) and for SE2 discs at 10 min (p < 0.05).

Gradual dehydration of μTBS testing specimens can cause significant changes in the test outcomes and should be avoided as a significant source of test variation.