Clinical Proof

The Dynamic Interaction of Water with Four Dental Impression Materials During Cure

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Abstract

PURPOSE:

The purpose of this work was to investigate the interaction of water with four different dental impression materials: Aquasil (Ultra XLV Type 3), Take 1 (Wash Refular Set), Genie (Light Body, Standard Set), and Impregum Garant (Soft Light Bodied Consitency).

MATERIALS AND METHODS:

Apparent contact angles of de-ionized water made against thin horizontal sample films of the different materials under different conditions were measured from analysis of profile images of symmetrical sessile drops of water placed on the sample films using a Model FTA200 dynamic drop shape analysis system, which included a JAI M30 high speed CCD camera combined with a zoom microscope. Data were taken for specimens of dry ages (times following mixing) from a minimum of 20 seconds up to 1220 seconds. Imaging was started before the initial water/impression material contact, and lasted for at least 420 seconds in each case. The interval at the beginning of each run was 0.033 second, and then increased by a factor of 1.012 to the end. During the initial 3 seconds following the drop deposition, the drop's shape oscillated due to inertial effects, so apparent contact angle data during this period were neglected in all cases. All measurements were made at room temperature. The drops were enclosed in a humidified chamber that suppressed evaporation. All data were repeated at least five times, and results were analyzed where appropriate using one-way ANOVA. Microscopic images of the water/impression material interactions for fresh (uncured) materials were acquired to reveal the destructive interactions that resulted from such contact. Finally, surface tension measurements were made of water that had been contacted with material of varying dry age using the pendant drop method capability of the drop shape analysis system. These helped to assess the origin of hydrophilicity development for the different materials.

RESULTS:

For short curing times (dry ages), water showed a destructive effect on the integrity of all of the impression materials, as evidenced by the formation of a crater beneath the water drop and a scum of material at its surface. These effects diminished with dry age until a critical curing time was reached, beyond which such destructive interactions were no longer detectable. These critical curing times were determined to be 80, 140, 110, and 185 seconds for Aquasil, Take 1, Genie, and Impregum, respectively. The initial contact angle following the respective critical curing time was lowest for Impregum, at 66 degrees ; while values for Aquasil, Genie, and Take 1 were 93 degrees , 104 degrees , and 110 degrees , respectively. Beyond the critical curing times for the different materials, different degrees of hydrophilicity were observed. Aquasil showed the lowest final contact angle (<10 degrees), with Impregum, Take 1, and Genie showing 31 degrees , 34 degrees , and 40 degrees , respectively. Measurements of the surface tension of water after contact with the different materials suggested that for Aquasil, hydrophilicity appears to be developed through the leaching of surfactant from the material, whereas for Impregum, Take 1, and Genie, hydrophilicity is developed at least in part through a change in surface structure in contact with water. Impregum and Aquasil materials of dry ages well beyond the critical curing time exhibited a stick-slip behavior in their interline movement or contact angle evolution. This was believed to be due to the slowness

in the leaching of surfactant (in the case of Aquasil) or the re-orientation of unleachable surface groups (in the case of the other materials) in comparison to the inherent kinetics of water drop spreading.

CONCLUSIONS:

All materials investigated in the fresh, uncured state showed qualitative decomposition when put in contact with water through the formation of a crater beneath the water drop and a scum of material at its surface. These effects diminished with curing time until beyond a critical value, no such effects were evident. The initial hydrophilicity of the materials as determined by the contact angles obtained at their respective critical dry ages was greatest for Impregum. Beyond the critical curing time, different degrees of hydrophilicity were observed, with Aquasil showing the lowest final contact angle.