Case Study

Occupational Allergic Contact Dermatitis due to Ultraviolet-Cured Acrylic Glue

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Since the methacrylate and acrylate compounds (acrylics) were developed in the 1930s, they have been widely used in a variety of products such as dental prostheses and tooth filling, printing inks, orthopaedic prostheses and splints, soft contact lenses, floor waxes, surface treatment of leather, textiles and paper products, nail cosmetics, and as glues, sealants and adhesives1–2). Ultraviolet (UV)-cured acrylic resin is one of the most convenient systems to use for dental materials, printing and glues. Acrylics have frequently been shown to cause allergic contact dermatitis (ACD) in both domestic and occupational environments. ACD due to (meth)acrylate derivatives in UV-cured resin have often been reported1–8). Acrylics are also reported to cause some types of adverse reaction when patch tested, such as active sensitization, latent reaction and late reaction9–15). Consequently, it is very difficult to perform patch testing with acrylics as the test may cause irritation and active sensitization at high concentration and false negative results at low concentrations. This report details ACD due to 2-hydroxyethyl methacrylate (2-HEMA) in UV-cured glue used in the computer industry and some adverse patch test reactions to (meth)acrylates.

Case 1

A 40-yr-old man developed itchy dermatitis on his hands (Fig.1) three months after he started assembling CD ROM drives (parts of a personal computer) with UV-cured acrylic glue without any skin protection measures. Material safety data sheets (MSDSs) showed that the glue was mainly composed of (meth)acrylates (Table 1). Patch testing was performed with 10, 5, and 1% of the glue in petrolatum, plastics and glue series (acrylates only) (Trolab®, Hermal, Renbek, Germany) and Japanese standards. Patch tests showed positive results to all of the concentrations of the glue, 2-HEMA(1% pet.), ethylene glycol dimethacrylate (EGDMA) (2% pet.), nickel sulfate (2.5% pet.), ammoniated mercuric chloride (1% pet.) and formaldehyde (1% aq.) at 3 d. After the reading of the patch tests, the subject complained of itching lasting for the next two weeks at the positive regions even with topical corticosteroid. The manufacturer of the UV-cured acrylic glue was informed of the patch test results and subsequently revealed that the glue contained 2-HEMA but no further details were provided. The subject continued to work assembling CD ROM drives, making efforts to avoid direct contact with the glue, with topical corticosteroid treatment. His dermatitis was abated during a few days off. The factory was notified of the results of the patch test and he was provided by the factory with thin plastic gloves. However he still complained of continuing itchy dermatitis and as a result was transferred to another division in the factory where the work did not require the use of the glue. The precise materials used in the plastic gloves could not be obtained.

Table 1. Information of components of ultra-violet cured glue on material safety data sheets (MSDSs)

<table>
<thead>
<tr>
<th>Component</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>acrylic oligomer</td>
<td>40–50%</td>
</tr>
<tr>
<td>acrylic monomer</td>
<td>40–50%</td>
</tr>
<tr>
<td>methacrylate monomer</td>
<td>7%&gt;</td>
</tr>
<tr>
<td>filler, photo-induced polymerizer, others</td>
<td>10%&gt;</td>
</tr>
</tbody>
</table>
Case 2

When patch testing was performed for Case 1, the prepared materials of all the concentrations of the UV-cured acrylic glue (10, 5, 1% in pet) were tested on a 39-yr-old female dermatologist. No irritation was observed but two weeks after the patch tests, the regions showed positive reactions which lasted for the next ten days. Active sensitization caused by the patch testing with the prepared materials of the glue was suspected. One year later the dermatologist developed dermatitis on the dorsal aspect of the foot when she wore a new pair of leather shoes over thin cotton socks. The dermatitis was cured with topical steroid in two weeks. When she wore the shoes again three months later, no skin eruption developed on her foot. Patch testing with the same materials was tested and showed positive results to 2-HEMA (1% pet.) and cobalt chloride (1% pet.) at 3 d and to EGDMA (2% pet.) and methyl methacrylate (MMA) (2% pet.) at 7 d.

Discussion

ACD due to (meth)acrylates in UV-cured acrylic-based resin have often been described[3-8] and 2-HEMA was reported as an allergen in a UV-cured acrylic system in one case in the manufacture of circuit boards[9]. UV-cured acrylic inks are also used to print labels on hard discs in the computer industry and have been reported to cause ACD[6]. In Case 1, the UV-cured glue was used for assembling CD ROM drives. Both cases in our present report showed positive results to 2-HEMA at 3 d. 2-HEMA was thought to be a causative substance because of the information provided by the manufacturer. However, according to MSDSs, the glue also contained acrylate monomer. Any kind of acrylate monomer commercially available was not tested so the possibility that the cause of dermatitis in Case 1 could have been multiple sensitization to some acrylate monomer as well as 2-HEMA remains to be considered. The positive reaction to EGDMA can be thought of as a cross-reaction between 2-HEMA and EGDMA. EGDMA often gives positive reactions in acrylic allergic patients[12, 13].

UV-cured acrylic systems mainly comprise three components: UV-reactive pre-polymer; thinner, normally multifunctional acrylates as a vehicle to cross-link the pre-polymers; and polymerizer to absorb UVA[6]. The polymerizer, most often used in UV-cured acrylic resin, is benzophenone[1-6], which can be a sensitizer, but Case 1 was not tested with this substance.

There are some reports about active sensitization due to (meth)acrylates[8-14]. Case 2 was actively sensitized by the prepared material at 10% of the UV-cured acrylic glue. Previously, even 2% of 2-HEMA commercially available was reported to cause active sensitization[1-14] and so, in order not to cause active sensitization, the concentration of 2-HEMA in the commercial series (Trolab) was reduced from 2% to 1%. 2-HEMA has been considered as a weak sensitizer according to animal studies[8] but it can be a strong sensitizer in humans[12]. Kanerva et al. reported a case actively sensitized by patch testing with undiluted “own” resin, acrylic dental adhesive, containing 2-HEMA at the concentration of 30–65% but a test concentration of 1% of the resin was safe[6]. The concentration (10%) of the prepared and patch-tested materials of the UV-cured acrylic glue in our current report was too high for patch testing. The concentration of 2-HEMA in the glue was not revealed by the manufacturer. In case of patch testing with “own” acrylics, it is very difficult to determine the adequate concentration. Ideally, MSDSs would provide enough information on the ingredients of suspected substances, and each ingredient could be tested at the recommended concentration when first patch tested. However, the way of showing the ingredients of acrylic products on MSDSs varies between manufacturers and furthermore, the information on MSDSs can be unreliable for many kinds of plastics[7].

Case 2 showed positive reactions to EGDMA and MMA at 7 d. It could have been either a late cross-reaction to 2-HEMA or due to active sensitization. If positive reactions are observed at 8–10 d, it is difficult to distinguish between active sensitization and late reaction[13]. Fowler reported a case showing a patch test positive reaction to MMA after 5 wk. It was a late reaction, which was confirmed by a second patch testing[15]. To verify the reaction of Case 2, a second patch test was performed and 2-HEMA, EGDMA, and MMA showed positive results at 3 d. Case 2 might have been sensitized to EGDMA and MMA commercially available by the first patch testing but there is still a possibility that it was a late cross reaction to 2-HEMA. There are some reports that 2% EGDMA[11-14] and 2% MMA[11, 12] currently commercially available cause active sensitization.

The cause of dermatitis that occurred on the dorsal aspect of foot in Case 2 due to a new pair of leather shoes might have been the leather used on the inner side of the shoes though the details of the leather was not investigated. Case 2 did not have a history of allergic diseases. Acrylics are used for surface treatment of leather[5].

Case 1 complained of itching for two weeks after patch testing although he had applied topical corticosteroid on the positive patch test regions. Case 2 also experienced latent reactions continuing longer than 2 wk without any topical treatment. Long-lasting reactions due to patch testing to (meth)acrylates have been reported[13, 14]. The latent reaction caused discomfort to both subjects.

One should be concerned when patch testing with (meth)acrylates that the patch test can result in active
sensitization, long-lasting reaction or late reaction. To avoid erroneous results, especially for (meth)acrylates, the reading should be taken later than 7 d or patients should be notified that it is important to report any reaction occurring after an official observation by a dermatologist.

Case 1 was not provided with any kind of gloves when he started to use the glue. To avoid sensitization, protective gloves should have been provided when he commenced using the glue. It is reported that a sensitized patient working in the silk screen industry was able to continue working by avoiding contact with acrylic products through wearing nitril rubber gloves over cotton gloves and using a scraper instead of a rag to clean the screen. Case 1 was provided with thin rubber gloves after he developed allergic contact dermatitis but they failed to prevent his symptoms reoccurring. Detailed information of the materials of the gloves could not be obtained. Acrylics readily penetrate rubber gloves. The 4H glove, a 5-layer laminate, can inhibit the penetration of acrylics but it is not a good anatomical fit for tasks needing dexterity and tactility. Therefore, a finger piece of 4H glove under a disposable glove is recommended, but this also is not a practical and handy way. Revising the procedures of work to minimize the contact with chemicals is very important.

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