Case Study

Occupational Allergic Dermatitis Induced by an Epoxy Hardener Alkylamine

Tomoyuki HANAOKA¹, Qing LI², Junko IMAGAWA³, Masahito TAGUCHI⁴, Masayasu MINAMI² and Shoichiro TSUGANE¹

¹Epidemiology and Biostatistics Division, National Cancer Center Research Institute East,

²Department of Hygiene and Public Health, Nippon Medical School,

³Imagawa Occupational Health Consultant Office and

⁴Department of Dermatology, Saitama Medical School, Japan

Key words: Dermatitis, Epoxy resin, Alkylamine, Asphalt, Patch test

Epoxy resins have been widely used in commercial applications, and their adverse health effects have been mostly reported in occupational settings. The most frequent adverse effects are irritation or allergic mechanisms involving the dermal and respiratory systems. Sensitization is usually caused by low molecular weight or short-chain compounds¹⁾.

We report here two workers exposed to an epoxy resin and a newly developed epoxy hardener, alkylamine, who developed severe dermatitis. The chemicals were used as components of asphalt. We identified the epoxy hardener as the causative material in the dermatitis by a patch test.

Cases

Case A was a 22-yr-old man who had been working in an asphalt production company. A severe eczema developed on his lower abdomen, lower back, thighs and knees after working with an epoxy resin (EA-100A-2 A, Albar Industry Co., Osaka, Japan) and an epoxy hardener, alkylamine (EA-100A-2 B, Albar Industry Co.). He was in charge of mixing these raw materials in a mixing unit in roadside areas (Fig. 1). Since the two materials were mixed at a temperature lower than 25–30°C, their vapor was unlikely to be generated during this process. He started operating the mixing machine in September 1999. Before the onset of the dermatitis in November 1999, he had been exposed to these substances approximately 14 times in two months. His main symptom was itching. The eczema appeared after returning home from work. When he handled these materials, he wore cotton or rubber gloves, but the substances sometimes adhered to

his skin. The atmospheric temperature was not high, so he did not sweat heavily. He had no personal or family history of allergic diseases including allergic rhinitis and urticaria. The symptoms continued for approximately 14 d. Unfortunately, no photograph of his skin lesion was available.

The company suspected that his eczema had developed from occupational exposure to these substances because no information on sensitization was included in the material safety data sheets (MSDSs). We developed a questionnaire survey for 21 company employees in June 2000. At that time, only three persons including case A were in charge of this mixing of materials. They started the operation at the same time.

In February 2001, a 19-yr-old man, case B, developed a severe systemic eczema (Fig. 2). He was one of the above three people. In the questionnaire survey, he reported a past history of mild eczema on his thighs. He operated the mixing machine in September 1999, April and August 2000. Before the onset of the dermatitis, he had been exposed to these substances for one week. The onset and symptoms were similar to those in case A. He became aware of his symptoms on the morning after exposure. When handling these materials he wore cotton gloves and work clothing. According to an interview with him, he perspired slightly during work. He had no past history of allergic diseases, although his family had a history of allergic rhinitis. His serum nonspecific IgE level was within the normal range (196 IU/ml, the normal range; < 361 IU/ml). The eosinophil count was also within the normal range. Serum C-reactive protein (CRP) was high (2.29 mg/dl, the normal range; 0.00–0.25 mg/dl), but no other abnormal result was observed in a routine biochemical examination. His symptoms vanished after approximately 14 d.

Patch test

We conducted patch tests for 14 workers including cases A and B. Except for these two, none of the other 12 had been involved in the mixing work. To determine the optimal concentration for patch testing, the epoxy

Fig. 1. Scheme for a production process of asphalt using an epoxy resin. Dermatitis occurred in two workers operating this mixing unit.

Received Feb 8, 2002; Accepted April 23, 2002

Correspondence to: T. Hanaoka, Epidemiology and Biostatistics Division, National Cancer Center Research Institute East, Kashiwanoha, Kashiwa, Chiba 277-8577, Japan

Fig. 2. Systemic dermatitis caused by an epoxy hardener alkylamine (Case B). A, chest and abdomen; B, back; C, leg; D, forearm.

A	B
C	D

resin and the epoxy hardener were patch tested at concentrations of 1% and 3% in two control subjects to rule out irritant reactions. The epoxy resin was dissolved with Vaseline, and the epoxy resin hardener with olive oil. A three percent concentration of the epoxy resin was a non-irritant. On the other hand, the epoxy hardener had irritants even at 1%. The irritant reaction caused severe itching and chronic pigmentation. According to this preliminary examination, we adopted concentrations of 1% and 2% for the epoxy resin, and concentrations of 0.25% and 0.5% for the epoxy hardener as the optimal concentrations for the patch tests. The patch tests were done according to the guidelines of the International Contact Dermatitis Research Group²⁾. After a 48 h-patch period, the covered surface was observed at 2 h, 24 h and 48 h. The results showed that no subject had a positive reaction to the epoxy resin except for case A at 2 h to 1% and 2% of the epoxy resin. Cases A and B both showed positive reactions to 0.25% and 0.5% of the hardener at 2 h, 24 h (Fig. 3) and 48 h. In case B, the reaction to the hardener at 24 h and 48 h (++; visicular) was greater than that at 2 h (+; erythema). No other subjects showed a positive reaction to either concentration of the epoxy hardener.

Discussion

Skin sensitization due to epoxy resin has been reported since the late 1950s³⁾. Epoxy hardener has also been known to cause contact dermatitis³⁾. Moreover, low molecular polyamines and alkanol polyamines have been pointed out as sensitization agents in road pavers⁴⁾. Two subjects of this study were exposed to an epoxy resin and an epoxy hardener alkylamine during operation of the mixing machine. The exact vapor pressure of these chemicals is not known, but they are not volatile chemicals. Taking into account the inside temperature of the mixing machine, the vapor of these chemicals was not likely to be generated during the process, but splashing might have occurred during the mixing. According to interviews, these materials sometimes adhered to users' skin. The MSDS of the epoxy hardener described its irritant effect, but provided no information on sensitization. Therefore, their skin protection was less than ideal.

The first clinical diagnosis for case B by a dermatologist was toxic exanthema. His skin lesion was like systemic urticaria. In case A, a similar lesion also appeared on the skin covered by his work clothes. A delayed allergic reaction caused by the epoxy hardener

Fig. 3. Results of patch tests for an epoxy hardener alkylamine (0.25% and 0.5%). A, case A at 2 h; B, case B at 2 h; C, case A at 24 h; D, case B at 24 h. Figure A includes results of patch tests for an epoxy resin (1% and 2%).

A	B
C	D

polyamine was confirmed by a patch test. One possibility is that the chemical splash had adhered to their clothing and thoroughly penetrated them, or the chemicals had adhered to their skin and then trickled down with sweat. Another possibility is that the chemicals cause systemic contact dermatitis.

Allergic contact urticaria is due to immediate-type hypersensitivity⁵⁾, and a previous report showed the simultaneous occurrence of immediate and delayed allergies caused by a polyamine⁶⁾. Although the serum nonspecific IgE level of case B was within the normal range, an immediate-type allergic reaction could not be excluded in these cases.

Case A also showed a positive reaction to the epoxy resin at 2 h, suggesting that the epoxy resin also partially contributed to his skin lesion.

High Serum CRP was observed in case B, and this was the only significant clinical finding, but this protein has been considered a nonspecific sign of acute inflammation in contact allergy⁷⁾. We speculate that this finding reflected a severe symptom in this case.

We also speculate that in these cases the manufacturer of these materials could not obtain sensitization information for the MSDSs. Screening tests of all newly developed materials are practically impossible. Integration of case reports and immediate risk

communications might be essential to prevent occupational allergic dermatitis in such cases. This case study is supposed to serve as a warning to users of polyamines in road pavement materials.

Acknowledgments: We are grateful Dr. Ichiro Hara for his helpful advice in the course of this research.

References

- 1) Bray PG. Epoxy resins. *Occup Med* 1999; 14: 743–758.
- 2) Fisher A. *Contact Dermatitis*. 3rd edition ed. Philadelphia: Lea and Febiger; 1986.
- 3) Cronin E. *Contact Dermatitis*. Edinburgh: Churchill Livingstone; 1980.
- 4) Levin JO, Andersson K, Hallgren C. Exposure to low molecular polyamines during road paving. *Ann Occup Hyg* 1994; 38: 257–264.
- 5) Wakelin SH. Contact urticaria. *Clin Exp Dermatol* 2001; 26: 132–136.
- 6) Edwards EK, Jr., Edwards EK. Contact urticaria and allergic contact dermatitis caused by paraphenylenediamine. *Cutis* 1984; 34: 87–88.
- 7) Moller H, Ohlsson K, Linder C, Bjorkner B, Bruze M. Cytokines and acute phase reactants during flare-up of contact allergy to gold. *Am J Contact Dermat* 1998; 9: 15–22.