

Case Study

A Case of Occupational Allergic Contact Dermatitis due to PVC Hose

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Polyvinyl chloride (PVC) is made by polymerizing vinyl chloride monomer and is a plastic that softens on heating. The addition of a small amount (<5%) of plasticizer produces a hard PVC, whereas the addition of 30 to 50% plasticizer results in a soft PVC. Soft PVC is used to make several products, including chemical shoes, cables, gloves, hoses, and film¹. The principal component of PVC hose is polyvinyl chloride (PVC), to which di(2-ethylhexyl) phthalate (DOP, from its alternative chemical name, dioctyl phthalate) is added. Other components are barium-cadmium carboxylic soap, lubricant, and pigment.

Despite its widespread use, reports of allergic contact dermatitis from PVC products are rare. One of the reasons for this is believed to be the difficulty in confirming a precise causative substance, which has prevented physicians from reporting cases. We encountered a case of occupational allergic contact dermatitis caused by PVC hose.

Case Report

The patient was a 55-yr-old guard who since 1991 had worked at a factory producing PVC hoses. In addition, he had been in charge of burning waste PVC hoses from 1992 to 1998. In 1999, a company specialized in handling waste PVC hoses took over the disposal of the waste PVC hoses. The patient used to wear cotton gloves, but no mask, while burning the hoses. After the patient started burning PVC hose in 1992, he initially developed pruritus on both upper limbs. Subsequently, scaly skin lesions developed and spread over his entire body, and he suffered from severe itching. These skin lesions did not disappear completely, although the patient stopped the burning work in 1998, they were chronic, and waxed and waned.

Recently, the patient visited the department of dermatology at our hospital for his skin lesions, which

had been aggravated for approximately 1 yr. Physical examination was unremarkable except for the skin lesions, which were erythematous scaly papules and patches. The lesions were on his face, neck, hands, back and legs. His medical history was non-specific, although he stated that his skin had been pruritic and sensitive since childhood. His family history was non-contributory. Routine laboratory examinations (complete blood cell count, electrolytes, urine exam, Mg, and hepatic and kidney function indices) were all normal. Fungus microscopy (KOH mount) was performed to test the possibility of a fungal infection, but was negative. A skin punch biopsy of his back showed epidermal spongiosis with some exocytosis of lymphocytes and superficial perivascular infiltrates in the dermis, which consisted of lymphocytes and eosinophils. These findings suggested the possibility of allergic contact dermatitis.

Patch tests were carried out to find out if there was a connection with the patient's work because he insisted that the lesions tended to worsen at work, but improved somewhat after work or during holidays. The patches used in the first test were PVC hose (Table 2) and the standard Korean occupational patch series. The PVC hose was ground and mixed with petrolatum in a 0.1% concentration. To test other unknown materials in the PVC hose, we extracted water- and ethanol-soluble fractions from the PVC hose by incubation with normal saline or 83% ethanol at room temperature for 1 h with or without heating (150 °C, 10 min). Then, we patched those liquid extracts from PVC hose in 0.1% concentrations². The patches were placed on normal looking skin on the arm or back and were removed after 2 d. They were read visually on days 2 and 4. The reactions were scored according to the International Contact Dermatitis Research Group guidelines³ (Table 1). However, the result of the first patch test was not reliable because most of the patched sites showed erythema (angry back reaction, a false-positive reaction). Therefore, a second patch test was performed with the PVC materials separated from each other by negative controls (Table 2). The site tested with ground PVC hose with petrolatum (0.1%) showed erythema and papules on both days 2 and 4 (1+ reaction).

The patient was diagnosed with systemic allergic contact dermatitis due to PVC hose as a result of occupational exposure and was referred to the Department of Occupational and Environmental Medicine for counseling regarding the occupational relationship. The Industrial Accident Compensation system was consulted, and recognized his rash as an occupational illness. To treat his skin lesions, oral corticosteroid (20 mg/d) was attempted, but no response occurred. Currently, he is on cyclosporine 200 mg/d and is asymptomatic.

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Table 1. The patch test reactions according to International Contact Dermatitis Research Group guidelines

Score	Patch test reaction	Criteria
–	Negative	No reaction
+?	Doubtful	Faint erythema only
+	Weak	Erythema, infiltration, possibly papules
++	Strong positive	Erythema, infiltration, papules, vesicles
+++	Extreme positive	Intense erythema and infiltration and coalescing vesicles

Table 2. Materials used and results of the patch test

Material		Concentration (%)	Reaction after 2 d	Reaction after 4 d
Normal saline + PVC hose fraction		0.1	–	–
Normal saline + PVC hose fraction + heating		0.1	–	–
83% Ethanol + PVC hose fraction		0.1	–	–
83% Ethanol + PVC hose fraction + heating		0.1	–	–
Petrolatum + PVC hose fraction		0.1	+1	+1
Controls	Normal saline		–	–
	83% Ethanol		–	–
	Petrolatum		–	–

Discussion

In this case, the precise causative chemical agent could not be identified; however, the skin punch biopsy suggested allergic contact dermatitis and the symptoms began to appear in regions that were exposed to PVC hose dust. The symptoms improved during the patient's days off and worsened on workdays. Since the patient was in charge of guarding the front entrance, his work environment was far from the factory site and he was not exposed to other substances in the factory. Moreover, he was not exposed to any other chemical during his normal daily life. The patch test carried out using a PVC hose gave a positive reaction. These facts strongly support the diagnosis of allergic contact dermatitis caused by chemicals present in the PVC hose.

Most occupational contact dermatitis occurs at sites of contact with the causative material, and is improved by removing the contact. In a few cases, particularly allergic dermatitis, the symptoms do not improve despite avoiding the causative material. In these cases, persistent, recurrent hypersensitivity is believed to have developed⁴⁾. Systemic allergic contact dermatitis is defined as a generalized allergic skin reaction caused by the inhalation or ingestion of an allergen to which the host has become sensitized after continuous external contact⁵⁾. It is characterized by erythematous papules, patches, or vesicles on the skin with generalized distribution with itching. Our patient is believed to have a systemic, persistent allergic reaction

because he inhaled PVC hose dust repeatedly for a long time, and has pruritic erythematous papules and patches on almost his entire body, although he is no longer exposed to PVC hose dust. It is not certain whether he had an atopic diathesis because his skin has been sensitive and dry since childhood. However, he was free of other skin symptoms before his exposure to PVC hose dust and smoke. His family and past history were also free of allergic diseases, such as atopic dermatitis, allergic rhinitis, and asthma.

The patch test is the most important tool for diagnosing allergic contact dermatitis. However, it is difficult to identify the causative material when a patient visits a hospital. In such cases, a patch test can be conducted by diluting the causative material to a concentration of 0.01% or 0.1% to avoid an irritation reaction²⁾. In cases when other chemicals are added to the material, the aqueous, ethanol, acetone, and methanol extracts need to be tested to exclude the possibility that the reaction is caused by water-soluble or lipid-soluble materials²⁾. Heating can be used to expedite the extraction. In our patient, the tests were carried out at a concentration of 0.1% with water (normal saline), ethanol, and petrolatum. Petrolatum is the preferred dispersing agent because it is suitably occlusive and non-irritating. In addition, heat was applied during the extraction.

The angry back syndrome, which occurred during the first patch test administered to our patient, is an adverse reaction that occurs when carrying out an epicutaneous

patch test battery that is characterized by multiple false-positive results. It is a type of irritant reaction that is usually induced by a previous inflammatory skin condition or by marginal irritants⁶⁾. To avoid an angry back reaction, the patch should be retested by placing the substances farther apart at least 1 wk later⁷⁾. In our patient, the cause of the angry back reaction was believed to be the false-positive reaction resulting from a severe allergic reaction over his entire body. Therefore, a second patch test was performed 2 wk after the first, and the possible causative PVC materials were placed farther apart. The patch test could be performed in only a few regions because skin lesions already covered his body. Only the patches of PVC materials were tested because of the high likelihood that the angry back reaction due to an additional inflammatory skin lesion would recur if the Korean occupational standard patch series were repeated.

Eleven cases of allergic contact dermatitis related to PVC have been reported in Medline. Kanerva *et al.*⁸⁾ described a case of allergic contact dermatitis that was caused by an organic pigment in PVC gloves, while Aalto-Korte *et al.*⁹⁾ reported a case of allergic contact dermatitis due to bisphenol A, which is used as an antioxidant and inhibitor of end polymerization in PVC gloves. In addition, Monma and Tusnoda¹⁰⁾ reported two cases of allergic contact dermatitis due to PVC gloves, and Aalto-Korte *et al.* stated that small amounts of the antimicrobial agent benzisothiazolinone in PVC gloves may sensitize those who already have hand dermatitis¹¹⁾. Koch and Nickolaus¹²⁾ reported a case of allergic contact dermatitis on both feet due to mercury chloride from a new pair of PVC boots, and Tung and Taylor¹³⁾ described a case of allergic contact dermatitis from a PVC identification band, which was concluded to be the result of unknown chemicals in the band.

Herve-Bazin *et al.*¹⁴⁾ reported allergic contact dermatitis from a PVC plastic table cloth, and Fregert *et al.*¹⁵⁾ showed that diphenylthiourea and its degradation product, phenylisocyanate, in a PVC adhesive can cause allergic contact dermatitis. Fregert and Rorsman¹⁶⁾ reported that the epoxy resin in the PVC film used in patch tests caused allergic contact dermatitis in 13 patients, while Huh *et al.*¹⁷⁾ described a case of allergic contact dermatitis due to a pyridine derivative in PVC leather. In a study examining the patch test results of 388 workers working at a factory producing shoes from PVC granulate, 11 were diagnosed with allergic contact dermatitis, of whom six were sensitized by phthalates and five were sensitized by coal tar¹⁸⁾.

Besides allergic contact dermatitis, cases of allergic eczema from PVC gloves and irritant contact dermatitis in children due to PVC identification bracelets have been reported^{19, 20)}.

Based on the material safety data sheet (MSDS) for the PVC hose, its components were PVC, di(2-

ethylhexyl)-phthalate (DOP), barium-cadmium carboxylic soap, lubricant, and pigment. In a literature review, the phthalates in PVC granulates were found to cause allergic contact dermatitis in shoe factory workers¹⁸⁾, DOP was reported to cause contact urticaria syndrome^{21, 22)}, and the organic pigment in PVC gloves was shown to cause allergic contact dermatitis⁸⁾.

Since the skin condition of our patient was poor, no further tests were carried out to identify the causative material. However, a substance in the PVC hose that could not be extracted with normal saline (water-soluble) or ethanol (lipid-soluble) is believed to have caused the allergic contact dermatitis.

Overall, cases of occupational allergic contact dermatitis caused by materials such as PVC products generally go unreported because doctors have difficulty identifying the causative material. The number of cases of allergic contact dermatitis is expected to increase because the use of PVC products is increasing in daily life and the work environment. Therefore, the continuous attention of physicians specializing in dermatology and occupational medicine is needed.

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