

Contact urticaria due to polyethylene gloves

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We report a rare case of contact urticaria due to polyethylene gloves. The patient, a 46-year-old cook, had had chronic urticaria since 1985, and first visited our hospital in June 2000. We began by prescribing antihistamine and antiallergenic drugs for him, but his condition did not improve. From a detailed interview, we established that when he put on polyethylene gloves at work, his condition worsened. We suspected some component of his gloves to be the cause of his symptoms. Prick and scratch tests with a solution extracted from his gloves showed a wheal-and-flare reaction at 15 min. We advised him to wear a cotton shirt under his clothes in daily life, and to put on cotton gloves under his polyethylene gloves while at work. Subsequently, the size and the number of wheals were markedly smaller and the subject's symptoms were reduced.

Key words: antioxidant; butylated hydroxytoluene (BHT); contact urticaria; cook; gloves; occupational; polyethylene. © Blackwell Munksgaard, 2002.

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Because polyethylene (PE) and polypropylene (PP) products are widely used daily (in school, home and working environments), skin problems due to PE and PP are likely to increase in the future. PE is a condensation of polymers of ethylene, and its chemical structure is $(-\text{CH}_2-\text{CH}_2-)_n$. PE is heat, chemical and biodegradation resistant. PE is also malleable, flexible and electrically resistant, though because it is easily oxidized, it has to have antioxidants added.

We report a rare case of contact urticaria due to gloves made of PE.

Case Report

A 46-year-old cook developed contact urticaria approximately 15 years ago. He had been treated at many hospitals and at a dermatological clinic. However, his condition did not improve. His elder brother had a rare allergy, contact urticaria syndrome due to di(2-ethylhexyl) phthalate (DOP) in the dotted polyvinyl chloride (PVC) grip of cotton gloves (1). The elder brother recommended our hospital to the younger brother, who first visited our hospital in June 2000.

We began by prescribing antihistamine and anti-

allergenic drugs for him, but his condition did not improve. Because he was a cook, we proposed scratch testing with foods that he handled often, pea pod, yuzu (a citrus fruit), ayu (sweetfish), Spanish mackerel and sharp-teethed sea eel. The results were weak positives (class 2 $\approx$ 3) to pea pod, ayu (sweetfish) and sharp-toothed sea eel. We advised him not to touch these directly, if possible, and his condition slightly improved. During a detailed interview, he mentioned that his urticaria usually got worse while at work wearing PE gloves (Fig. 1). We suspected that some component of his gloves was a further cause of his symptoms.

IgE RIST was in the normal range. IgE RAST to tomato, carrot, pumpkin, and grapefruit were class 2, avocado and natural rubber latex were class 1, and salmon, cuttlefish, octopus, mackerel, horse mackerel, sardine, anisakis, chestnut, mango, banana, quail and dog dander were class 0.

Materials and Methods

Extraction of components of gloves

We suspected contact urticaria due to a component of his gloves, which were made of polyethylene



Fig.1. Gloves.

with additives. We extracted the components of these gloves with hexane, chloroform and methanol, the extracted solutions being separated by column chromatography.

Five grams of glove shavings were put in a 500-mL eggplant-shaped flask with 100 mL acetone and heated at 150°C on a sand bath for 30 min. After filtering with a glass filter (3G160), the solution was extracted again with 100 mL methanol for 30 min. We concentrated the extract solution to 10 mL by rotary evaporator.

Identification of components in his gloves

We analyzed the extract solution by column chromatography, identifying the separated chemicals using Fourier infrared absorption spectropho-

tometry (FT-IR) (2, 3) and gas chromatography/mass spectrometry (GC/MS) (3, 4).

Fourier infrared absorption spectrophotometry (FT-IR)

The separated solutions were put on cell board (KRS-5) and measured with a Fourier transform infrared spectrophotometer (FTIR-8900).

Gas chromatography/mass spectrometry (GC/MS)

One μL of each separated solution was injected. The conditions were as follows:

- apparatus: MAT 90 mass spectrometer (Finnigan, Bremen, Germany);
- column: 5% phenylmethyl silicon (0.25 μm thickness), DB-5MS (J & W), 0.25 mm id $\times$ 30 m length;
- carrier gas: helium 1.5 mL/min;
- column temperature: 50°C (3 min) $\rightarrow$ rising by 10°C/min $\rightarrow$ 320°C (5 min) $\rightarrow$ cooling, ionization mode, electron ionization (EI) 70 eV.

Scratch and prick testing

We performed scratch or prick testing with the extracts, using histamine hydrochloride 1% aq. as a positive control, and distilled water and white petrolatum as negative controls. Water-soluble materials were prick tested. Materials mixed with petrolatum were scratch tested. Readings were made 15 min later, according to Lahti (5), as follows: –,

Table1. Chemicals detected in each fraction

No.	Elution	Chemicals detected
0	acetone and methanol	paraffin, silicon, 2,6-Di-tert-Butylphenol, di(2-ethylhexyl) phthalate (DEHP), cis-13-Docosenoic acid amide (Erucamide), octadecyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate (Irganox 1076)
1	hexane	paraffin, silicon
2	hexane: chloroform	silicon, phenylmethoxynaphthalene
3	chloroform	2,6-di-tert-butylphenol, di(2-ethylhexyl) phthalate(DEHP), octadecanoic acid methyl ester, octadecyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate (Irganox 1076)
4	chloroform: methanol	2,6-di-tert-butylphenol, di(2-ethylhexyl) phthalate(DEHP), octadecanoic acid methyl ester, cis-13-docosenoic acid amide?Erucamide), octadecanoic acid amide, octadecyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate (Irganox 1076)
5	methanol	2,6-di-tert- butylphenol

Table2. Chemicals analysed in gloves

Antioxidants	Lubricants
octadecanoic acid amide	paraffin
2,6-di-tert-butylphenol	phenylmethoxynaphthalene
di(2-ethylhexyl) phthalate(DEHP)	octadecanoic acid methyl ester
cis-13-docosenoic acid amide (Erucamide)	
octadecyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate (Irganox 1076)	

Table 3. Skin test results

Materials	Wheal reaction (D + d)/2 15 min	Wheal reaction (D + d)/2 30 min
No. 0	0	0
No. 1	0	0
No. 2	0	0
No. 3	6	6
No. 4	0	11
No. 5	6	11
di(2-ethylhexyl) phthalate(DEHP)	10	20
2,6-di-tert-butylphenol	13	13
octadecyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate (Irganox 1076)	12	13
octadecanoic acid amide	8	11
octadecanoic acid methyl ester	11	14
cis-13-docosenoic acid amide (Erucamide)	11	16
distilled water	0	0
white petrolatum	0	0
histamine chloride	5	
gloves	11	

not reacted, 2+, $\frac{1}{2}$ histamine solution's reaction-sized erythema and $\frac{1}{2}$ histamine solution's reaction-sized oedema, 3+, histamine solution's reaction-sized erythema and histamine solution's reaction-sized oedema, 4+, stronger reactions of erythema and oedema than those of histamine solution.

Control testing was conducted on three healthy

persons, all of whom reacted negatively to the extracts.

Histopathological study

We excised skin specimens from patch test sites, under local anesthesia, and fixed them in 4% paraformaldehyde, using paraffin wax for embedding.

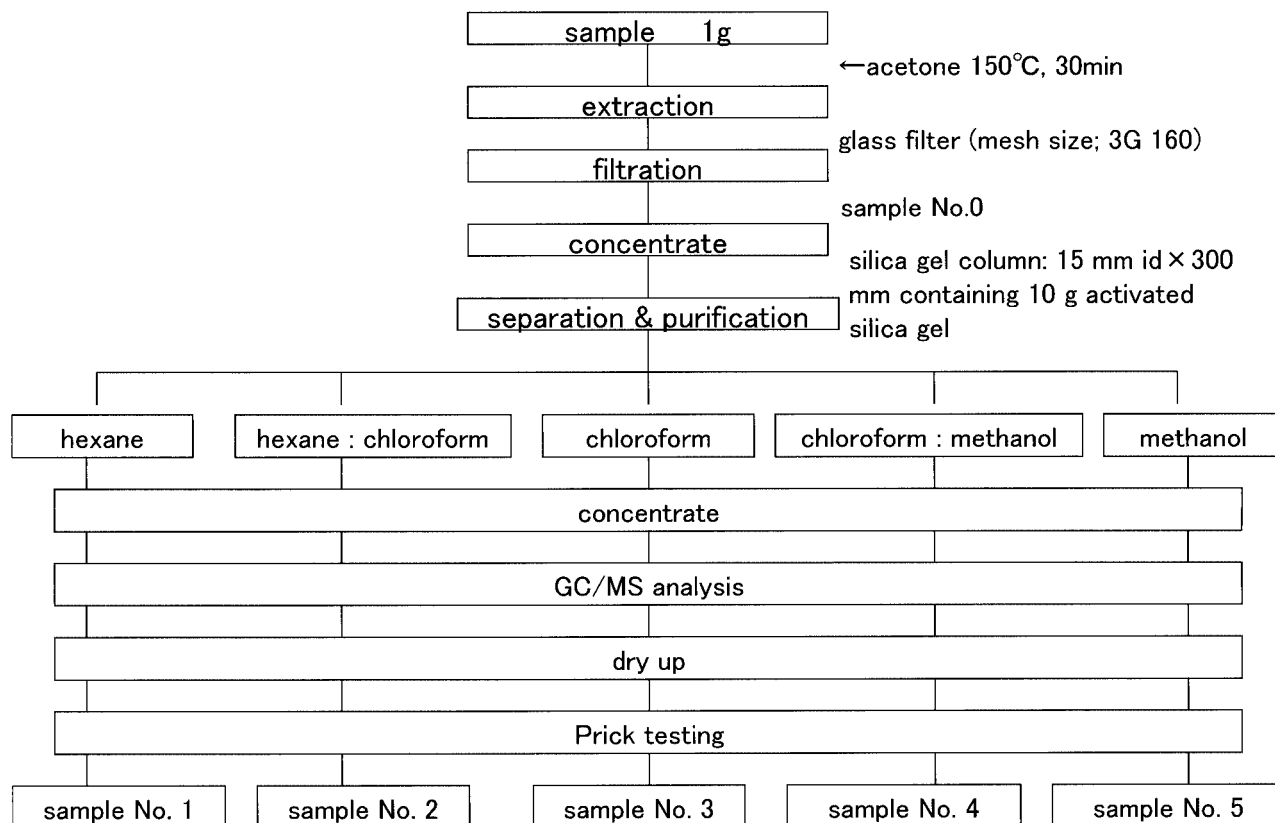


Fig. 2. Analysis and detection procedure for polyethylene.



Fig.3. Positive skin reactions.

We cut the skin specimens at $3\mu\text{m}$ and stained them with hematoxylin and eosin.

Results

Chemicals analysed (Tables 1 and 2, (Fig. 2))

We detected the following chemicals in the extract and separated solutions: silicon, paraffin, 2,6-di-tert-butylphenol, di(2-ethylhexyl) phthalate (DEHP), *cis*-13-docosenoic acid amide (Erucamide), octadecyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate (Irganox 1076) in the extract, silicon and paraffin in the hexane elution, silicon and phenylmethoxynaphthalene in the hexane and chloroform elution, octadecanoic acid methyl ester, 2,6-di-tert-butylphenol, di(2-ethylhexyl) phthalate (DEHP), *cis*-13-docosenoic acid amide (Erucamide), octadecyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate (Irganox 1076) in the chloroform elution, 2,6-di-tert-butylphenol, octadecanoic acid amide, octadecanoic acid methyl ester, di(2-ethylhexyl) phthalate (DEHP), *cis*-13-docosenoic acid amide (Erucamide) in the chloro-

form and methanol elution, and 2,6-di-tert-butylphenol in the methanol elution.

Scratch testing (Fig. 3, Table 3)

The results of scratch testing are shown in Table 3. We found positive reactions to the separated solutions nos. 3, 4, and 5, octadecanoic acid methyl ester, 2,6-di-tert-butylphenol, di(2-ethylhexyl) phthalate (DEHP), *cis*-13-docosenoic acid amide (Erucamide) and octadecyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate (Irganox 1076). Petrolatum and distilled water were negative.

Histopathological findings

A skin biopsy from the area where the positive reaction developed showed lymphocytes and eosinophils infiltrating around the capillaries in the dermis.

Discussion

We report a case of contact urticaria due to gloves made of polyethylene (PE). When we carried out scratch testing with their components, we demonstrated positive results with the separated solutions nos. 3, 4 and 5. We found positive reactions to detected chemicals octadecanoic acid methyl ester, 2,6-di-tert-butylphenol, di(2-ethylhexyl) phthalate (DEHP), *cis*-13-docosenoic acid amide (Erucamide), and octadecyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate (Irganox 1076) at 15 min. We assume that one of these chemicals caused his symptoms. These components are used in PE and PP as antioxidants and lubricants. There is a vast amount of PE in the world, in films, insulation, pipes, hoses, toys and containers for cosmetics, etc. It is a very difficult problem for such a patient as this to avoid all these products.

PE is easily oxidized, and an antioxidant is used to avoid such oxidation. Antioxidants are used not only in PE but also in foods and other plastic products, for example. Goodman et al. (6) reported BHA and BHT as antioxidants capable of aggravating symptoms in patients with chronic urticaria. Di(2-ethylhexyl) phthalate (DEHP), *cis*-13-docosenoic acid amide (Erucamide) and octadecyl 3-(3,5-di-tert-butyl-4-hydroxyphenyl) propionate (Irganox 1076) were all used as antioxidants in the gloves the patient used.

Osmundsen (7) reported a case of contact urticaria from plastic additives. Previously, we reported contact urticaria due to di(2-ethylhexyl) phthalate (DOP) in cotton gloves with PVC dots (1). Although a quantity of DOP is used in everyday goods at present, DOP may become avoidable

in daily life in the future. Our Ministry of Economy, Trade and Industry has issued a warning to reduce the amount of DOP in products. Since PE products are not likely to decrease in the future, it will remain difficult for the patient to avoid PE. He may come into contact with these antigens every day and his condition may therefore worsen.

This patient has had stage 2 contact urticaria syndrome (CUS) (8). Such symptoms are a serious problem in his daily life and make him feel uneasy. When he handles certain things in his daily life, he makes sure to put on cotton gloves. In spite of this, his condition might gradually worsen from stage 2 to stage 3 or 4 (8). If left without finding the causative agent, he might have developed life-threatening anaphylactic reactions, because PE products are widely used in the occupational and medical fields. The number of products containing antioxidants is even greater than all the PE and latex products in the world. We fear that the number of cases of PE additive allergy may increase in the future. We urgently need new medical instruments not only free from DOP and latex but also free from PE and antioxidants.

We conclude that when we see patients with chronic urticaria, we should make every effort to find out the causative agents, to treat their emotional reactions to their condition and to educate them in how to avoid products containing the causative agents.

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