

Contact allergy to two synthetic plastics in an orthopaedic engineer

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Case Report

The patient was a 27-year-old female with a history of flexural atopic eczema from the age of 5 years. In 1995, a hand eczema had started between the fingers and around the wrists, but also around her mouth and eyes and on her neck; this had recurred occasionally, and she had been treated with topical corticosteroids prescribed by a private dermatologist in 1997. She had worked in Norway at our hospital's Orthopaedic Technical Unit as an orthopaedic engineer from 1999 until September 2000. The occupational physician referred her to us in April 2001 because of increasing eczema around her mouth and eyes for a few months and a suspicion of occupational contact dermatitis caused by exposure to thermosetting polymers, such as epoxy resins and acrylates. She told us that she worked with ethylene–vinyl acetate plastic, but also with hard plastic materials, which she polished, and she also cast plastics to form casings to be used on prostheses. She also made fibreglass casts involving polyurethane exposure, and worked a lot with plaster of Paris. Whenever she used gloves, they were made from vinyl. There was no epoxy resin exposure in her workplace. She had only slight remnants of eczema on her dorsal fingers and wrists when seen by us in April 2001.

Patch testing in April 2001 was performed with our baseline series containing a phenol-formaldehyde resin (PFR) based on phenol and formaldehyde (PFR-2) (1) and DGEBA epoxy resin and an acrylate series, and also 4,4'-diaminodiphenylmethane (4,4'-MDA), diphenylmethane-4,4'-diisocyanate (4,4'-MDI), and bisphenol A, the last of these because she worked with vinyl gloves. Readings were performed on D3 and D7,

with negative patch test results, and the patient was diagnosed as having irritant contact dermatitis.

In August 2006, when the patient was still working at the Orthopaedic Technical Unit at our hospital as in 2001, she was again referred to us because of eczema around her eyes and mouth, in flexures, and on her neck. We were informed by the patient that she had seen one new erythematous skin reaction on her back 3 weeks after the first patch testing in April 2001, but she had never contacted us. She also informed us that her atopic eczema had become worse over the years, but had much improved in the preceding months. As we could not be sure whether the reaction on her back seen only by her in 2001 had been a late patch test reaction (2–4), she was again patch tested with our baseline (still containing PFR-2 and DGEBA epoxy resin) and acrylic series, and also with bisphenol A, 4,4'-MDA, 4,4'-MDI, PMDI, polymeric diphenyl methane diisocyanate (PMDI), and ethyl cyanoacrylate, the latter present in our acrylate series.

Multiple contact allergies were shown (Table 1).

Table 1. Positive patch test results on D3 and/or D7 on the test occasion in August 2006; all test substances were tested in pet.

Test substance	Test concentration		
	(% wt/wt)	D3	D7
4,4'-MDI ^a	2.0	+++	+++
Pedilen ^{®b}	2.0	+++	+++
4,4'-MDA ^c	0.25	+++	++
PFR-2 ^d	1.0	++	+++
Gold sodium thiosulfate	2.0	–	++
Palladium chloride	2.0	–	+
Oxidized limonene	3.0	++	–

^aDiphenylmethane-4,4'-diisocyanate

^bPMDI.

^c4,4'-Diaminodiphenylmethane.

^dResol resin based on phenol and formaldehyde.

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Discussion

There is one Danish report of occupational contact dermatitis in orthopaedic hospital staff working with Scotch Cast™ soft casts (3M, Glostrup, Denmark), in which the nursing staff of an orthopaedic outpatient clinic, consisting of 10 persons, were interviewed and subjected to patch testing with five types of diisocyanate, including 4,4'-MDI, 4,4'-MDA, and isophorone diisocyanate (5). No contact allergy to isocyanates was shown. The authors suggested that diisocyanates are primarily irritants rather than sensitizers in the professional setting studied. The skin symptoms of irritation were all mild and temporary (5).

Our patient was probably sensitized to the plastics during 2001–2006, even though she did not suffer from any dermatitis at presentation in August 2006. She was exposed to 4,4'-MDI and PMDI at work; she used vinyl gloves when she could, but not when performing delicate work and polishing hard plastic. 4,4'-MDI is the most commonly used diisocyanate in industry, with applications in areas such as the production of soft and rigid foam, coatings, adhesives, elastomers, and lacquers. 4,4'-MDA is used as catalyst in the production of polyurethane, and has been proposed to be a marker for MDI contact sensitization (6, 7). It has been suggested that 4,4'-MDI might be a poor representative of the products that patients are in fact exposed to, because, within industry, technical-grade isocyanate products are often used. Technical MDI products, often referred to as PMDI, generally contain a complex mixture of isocyanates in which 4,4'-MDI predominates, followed by oligomers containing predominantly three to six aromatic rings, but also smaller amounts of oligomers containing a higher number of rings (8). Our patient was tested with a PMDI, Pedilen, with a monomer content of 38.9% 4,4'-MDI (9). We have also shown that allergic reactions to 4,4'-MDI and PMDI can appear late without being a sign of patch test sensitization; that is, the positive patch test reactions in patients with previously known contact allergy to these substances can appear later than D7, and even later than D10 (8).

PFR-2 is stated to be a PFR based on phenol and formaldehyde. Even though there are various resins based on phenol and formaldehyde, PFR-2 has been shown to be a good marker for contact allergy to such resins (1). In the past, it was shown that not only did patch testing with PFR-2 detect patients who were allergic to the specific resol resin, but that simultaneous allergic reactions were also seen to fragrance mix I, colophony, and *Myroxylon pereirae* (10, 11). In our case, this was not seen. Binders based on PFR-2 are used in the production of adhesives, laminates, impregnation products, surface

coatings, and casting sand, and many cases of allergic contact dermatitis have been published. PFRs are known to be both irritants and potent sensitizers, and contain methylol-substituted monomers and dimers, which are the major sensitizers (1). The common *p-tert*-butylphenol-formaldehyde resin (PTBP-FR) present in most baseline series does not detect contact allergy to PFRs based on phenol and formaldehyde, whereas patients allergic to this latter resin will be missed if PFR-2 is not tested (1, 11). Simultaneous reactions to PTBP-FR and PFR-2 range from 10% to 20% in patch tested patients. Allergic reactions to PFR-2 can appear late; for example, on comparison of the patch test results for PFR-2 on D3 with those on D7 in a multicentre study in Sweden, it was shown that 25.9% of the allergic reactions would have been missed had a D7 reading not been performed (11). In our case, the clinical relevance of PFR-2 contact allergy was uncertain, as we could not obtain information on whether this allergen was present in her work materials. Nothing indicated the presence of PFRs in her domestic life.

The patient had experienced metal intolerance from adolescence, and never used cheap jewellery, but lacked a history of gold intolerance and had no dental gold. As palladium cross-reacts with nickel, her palladium allergy might have been a cross-reaction to nickel, even though we could not show current nickel reactivity when patch testing (12). Also, in those cases, the nickel reactivity is usually high, which, in this case, rather favours primary sensitization to palladium. The contact allergy to oxidized limonene could represent exposure to fragrances, but the patient denied ever having problems with fragrances. Limonene can also be used as a degreaser in industry. Our patient's personal care products, such as soaps and shampoos, were analysed for limonene and were negative.

Our patient was shown to have contact allergy to six different substances (4,4'-MDI, 4,4'-MDA, PFR-2, gold sodium thiosulfate, palladium chloride, and oxidized limonene). Interestingly, none of these are present in most baseline series, showing the need to test additional substances representing ubiquitous sensitizers in the environment, both domestic and occupational, as knowledge on which contact allergy exists is a prerequisite for further exploration with regard to exposure and clinical relevance, to finally enable a correct diagnosis of allergic contact dermatitis to be made (13).

Our patient was thus allergic to raw materials used in two different synthetic plastics – PFRs and isocyanates. From the material safety data sheets, we know she was exposed to 4,4'-MDI in Pedilen®, but we do not know whether a PFR was present in a glue or laminate. The contact allergy to the isocyanate was considered to be

work-related, and a plausible explanation for the facial and hand dermatitis, whereas the contact allergy to PFR-2 was of unknown relevance.

In a recent article, we stressed the importance of worksite visits, but, if patients are not very eager, worksite

visits cannot be forced upon them (14). In this case, we made several attempts to make a worksite visit, but were unfortunately unsuccessful.

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