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Two cases of occupational allergic contact dermatitis from a cycloaliphatic epoxy resin in a neat oil: Case Report

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Abstract

Background

Metal-working fluids contain complex mixtures of chemicals and metal workers constitute a potential risk group for the development of allergic contact dermatitis.

Case presentation

Two metal workers developed allergic contact dermatitis on the hands and lower arms from exposure to a neat oil used in metal processing. Patch testing revealed that the relevant contact allergen was a cycloaliphatic epoxy resin, 1,2-cyclohexanedicarboxylic acid, bis(oxiranylmethyl) ester, added to the oil as a stabilizer. None of the patients had positive reactions to the bisphenol A-based epoxy resin in the standard series.

Conclusions

These cases emphasize that well-known contact allergens may show up from unexpected sources of exposure. Further, it can be a long-lasting, laborious process to detect an occupational contact allergen and cooperation from the patient and the manufacturer of the sensitizing product is essential.

Background

In metal manufacturing processes metalworking fluids are sprayed onto the metal surfaces to reduce damage to the tools and facilitate the shaping of the metals.

Metalworking fluids may comprise a multitude of components such as: emulsifiers, biocides, extreme pressure additives, corrosion inhibitors, coupling agents, stabilizers, antifoam agents, dyes, fragrances, and water. Several of the components are irritant and sensitizing hence contact dermatitis is a frequent skin disease in metal workers exposed to metalworking fluids. Sensitization from additives in emulsifiable oils is most common, and biocides are one of the most frequent allergens in oils. Also corrosion inhibitors, coupling agents and emulsifiers have been reported as allergens. Neat oils are used undiluted and therefore contain only few additives. Here are presented two cases of allergic contact dermatitis caused by a cycloaliphatic epoxy resin in a neat oil, an old allergen in a new environment.

Case presentations

Two male machine workers with no history of dermatitis or atopy worked at a factory manufacturing steel backing plates and shims for disc brake pads when they developed dermatitis on the hands and lower arms. The skin problems started a few days after the introduction at their workplace of a new neat oil for cooling and lubrication during the metal forming processes. The dermatitis worsened whenever they were in contact with the oil and improved during vacation periods.

Patch Tests

Patch tests were performed with the European standard series (TRUE test panel 1 and 2 (AlkAbello, Hørsholm, Denmark) supplemented with petrolatum based patch test preparations (Chemotechnique, Malmö, Sweden) in Finn Chambers (Epitest Oy, Helsinki, Finland) on Scanpor (Alpharma AS, Oslo, Norway). Due to a suspicion of an epoxy allergy an epoxy series was included. The patients were also tested with the neat oil undiluted and semi-occluded under Scanpore tape. Subsequent testing was done with fractions containing the constituents of the oil kindly supplied by the manufacturer. The fractions were in concentrations equal to the finished oil product using mineral oil as vehicle and they were also tested undiluted and semi-occluded under Scanpore tape.

Results

The standard series showed no reactions except a doubtful reaction to epoxy resin in one of the patients, while the oil showed a ++ reaction at D3 in both patients. The reactions to the semi-occluded patches with the neat oil were vesicular and suggested the presence of contact allergy. Six coded fractions containing the constituents of the oil were tested on the patients. Only one fraction provoked a ++ reaction at D3 in both patients. According to the manufacturer this fraction contained a chlorinated aliphatic hydrocarbon (chlorinated paraffin). In the epoxy series a cycloaliphatic epoxy resin 0.5% pet. was positive with a ++ reaction on D3 for one patient and a +++ reaction for the other. The manufacturer then confirmed that the cycloaliphatic epoxy resin was contained in the positive fraction and present in the oil. The cycloaliphatic epoxy resin was 1,2-cyclohexanedicarboxylic acid, bis(oxiranylmethyl) ester (CAS no. 5493-45-8) (fig. 1), a diglycidyl ester of hexahydrophthalic acid. One of the patients also reacted to a reactive

diluent in the epoxy series, phenyl glycidyl ether 0.25% pet. (++) at D3) and bisphenol F 0.25% pet. (+ at D7).

Twenty-five consecutive eczema patients served as controls and were patch tested with the oil undiluted and semi-occluded. Also the fraction of the oil to which the patients had positive reactions was tested on 10 consecutive patients. All controls were negative.

Discussion

More than 90% of manufactured epoxy resins are based on the diglycidylether of bisphenol A (DGEBA) (fig. 1), while the remaining 10% non-DGEBA epoxy resins are based on the diglycidyl ethers of bisphenol F, cycloaliphatic compounds or other more complex systems (1). Epoxy resins are organic chemicals that contain more than one epoxy group. The most common epoxy compound is made from reacting bisphenol A with epichlorohydrin creating low-molecular weight polymers. The polymers are polymerized using curing agents (hardeners) as for instance polyamines or polyamides that cross-link the polymers creating a very stable network. Epoxy resins have a series of very useful properties such as excellent electrical qualities, low shrinkage, good adhesion to many metals and resistance to moisture, thermal and mechanical shock. They are used widely in adhesives, high performance coatings, electrical insulation, paints, inks, PVC products etc.

Most uses of epoxy resins require polymerization and hardening of the epoxy compounds, but when used as additives in oils the compounds retain their allergenic properties. According to the manufacturer the neat oil used by our patients is a lubricating/cooling stamping oil consisting of mineral oil, chlorinated paraffins, extreme pressure and antirust additives. The cycloaliphatic epoxy resin is added to the oil to

stabilize by scavenging free chloride radicals that appear due to thermal decomposition of chlorinated paraffins. The epoxy resin was added at a concentration of 0.25%. There are only few reports of sensitization from cycloaliphatic epoxy resins in oils. English reported in 1986 five cases of allergic contact dermatitis also from the cycloaliphatic epoxy resin, 1,2-cyclohexanedicarboxylic acid, bis(oxiranylmethyl) ester in a cutting oil (2). In 1988 Danneker published a case of allergic contact dermatitis from a cycloaliphatic epoxy resin in a Microscopy immersion oil and in 2001 Maibach presented a case of allergy to a cycloaliphatic epoxy resin in a hydraulic fluid (3, 4). In the late 90's an epidemic of allergic contact dermatitis from epoxy resins in Leica Microscopy immersion oil occurred. At least 24 cases have been reported in Europe and in some of these cases a cycloaliphatic epoxy resin was shown to be one of the allergens, but probably not the primary sensitizer in most cases (5-9). Allergic contact dermatitis from a cycloaliphatic epoxy resin has also been reported from electrical insulators and pre-impregnated carbon fiber (10, 11).

In aimed patch testing during the last ten years at our department, 5 of 57 patients tested had positive patch test reactions to cycloaliphatic epoxy resin (table 1). Two of the five cases are the ones reported here. In the remaining three cases the reactions were occupationally relevant to the patients as they were in contact with epoxy resin at their work place. One renovated drain pipes, another did road work and a third patient was a laboratory technician who examined microscopic preparations using Leica Immersion oil containing cycloaliphatic epoxy resin. In these 3 cases strong reactions to the DGEBA epoxy in the standard series were also seen and this compound was probably the primary sensitizer. Our two case-patients, however, showed either no reaction or a

doubtful reaction to the standard DGEBA epoxy. It has been reported in several cases that the standard series often does not uncover an allergy to a non-DGEBA epoxy (12, 13). It is important to supplement the standard patch test with the relevant epoxy resins to which the patient has been exposed.

In addition to the cycloaliphatic epoxy resin, patch testing of one of the case-patients also revealed a positive reaction to the reactive diluent, phenyl glycidyl ether. Phenyl glycidyl ether is usually added to decrease viscosity. Of the 5 patients tested allergic to cycloaliphatic epoxy resin at our department 4 also reacted to phenyl glycidyl ether. A total of 6 patients reacted to phenyl glycidyl ether in aimed testing of 57 patients. This possibly indicates cross-reactivity between the cycloaliphatic epoxy resin and the reactive diluent (14).

It may be that sensitization from some additives in oils occurs more frequently than indicated by the number of published cases, because the allergenic component often remains undetected. Scerri reported 12 cases of allergic contact dermatitis with positive reactions to the chlorinated paraffin component of a neat cutting oil (15). They did not find the sensitizer, which they believed to be a stabilizer, due to insufficient cooperation from a manufacturer. Detection of the allergenic component can be a very lengthy process that requires several visits from the patient for repeated patch testing. Cooperation from the manufacturer of the sensitizing product for acquisition of samples and information is also a necessity. However, it is important to identify the allergenic component in a case of allergic contact dermatitis. This may increase our knowledge and facilitate future investigations of dermatitis and it may also promote elimination of the allergen from the work place or from the sensitizing product preventing other cases of

allergic contact dermatitis. Following the investigation of the two cases of allergic contact dermatitis presented here, the manufacturer of the neat oil substituted the cycloaliphatic resin in the formulation with an alternative compound.

Conclusions

These cases emphasize that well-known contact allergens may show up from unexpected new sources of exposure. It can be a long-lasting, laborious process to detect unexpected occupational allergens. Investigation of the composition of allergenic working materials is required and cooperation from the patient and the manufacturer of the sensitizing product is essential.

Authors' contributions

Both authors took part in the clinical examination and testing of the patients and in the writing of the manuscript. Both authors approved the final version of the manuscript.

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Figures

Figure 1 - Chemical structures.

Chemical structures of Bisphenol A and 1,2-cyclohexanedicarboxylic acid, bis(oxiranylmethyl) ester.

Tables

Table 1 - Patch test reaction for patients positive to cycloaliphatic epoxy resin.

Patch test reactions to DGEBA epoxy, cycloaliphatic epoxy resin and phenyl glycidyl ether for patients tested positive to cycloaliphatic epoxy resin in a ten year period at Department of Dermatology, Odense University Hospital, Denmark.

	DGEBA epoxy (standard series)		Cycloaliphatic epoxy resin (epoxy series)		Phenyl glycidyl ether (epoxy series)	
	<i>D3</i>	<i>D7</i>	<i>D3</i>	<i>D7</i>	<i>D3</i>	<i>D7</i>
Case-patient	?+	-	++	++	-	-
Case-patient	-	-	+++	+	++	+
Sewer worker	++	+++	+	+	++	++
Road worker	+++	NT	+	NT	++	NT
Lab. technician	++	++	+	NT	+	NT

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Reviewer's reports

Two cases of occupational allergic contact dermatitis from a cycloaliphatic epoxy resin in a neat oil: Case Report

Report from Carola Lidén

Comments

1. A table, in the results section, describing the different epoxy-containing test substances (epoxy series, neat oil, 6 fractions) and the results would support understanding and over-view.
2. The name of the product, of the manufacturer and of the new alternative compound would be of significant interest. If the authors are not permitted by the manufacturer to publish this information, this should be mentioned.
3. Was information concerning the ingredients (including cycloaliphatic epoxy resin and other known sensitisers) available on the label or in safety data sheet? Do the authors think that such information should be readily available? This could be discussed.
4. "Competing interests" or not ? should be declared.

Level of interest

A paper whose findings are important to those with closely related research interests

Quality of written English

Acceptable

Report from P. Koch

General comments

This is a good paper contributing to the better knowledge of new sources of exposure from known contact allergens.

In my experience, patients may be sensitized very quickly, a few days or weeks after occupational contact with epoxy resins. This could also apply to the two machine workers ("case presentation"). This is an important point which should take place in the discussion if a reference can be provided.

Details

1. In the section "case presentation" the authors should indicate if the dermatitis of the hands and lower arms was clinically an allergic or an irritant contact dermatitis, or if both applies.

2. It should be indicated if the occlusion time of the patch tests was 24 or 48 hours and when the readings were done (24, 48, 72 hours? and D7?).

3. In "Results":

* At what reading the authors noted the doubtful reaction to epoxy resin in the standard series?

* A table should be integrated in the text with the results of the readings (D1?, D2, D3, D7?) of the chlorinated paraffin (and its concentration in the neat oil), the cycloaliphatic epoxy resin, phenyl glycidyl ether and Bisphenol F.

Level of interest

A paper whose findings are important to those with closely related research interests

Quality of written English

Acceptable

Report from Marius Rademaker

1. Are the conclusions drawn adequately supported by the data shown: if not, what are the shortcomings and could they be overcome?

Yes they are

2. Are sufficient details provided to allow replication of the work or comparison with related analyses: if not, what is missing?

i). They should describe their technique of patch testing in greater detail: ie how long patches were applied for, when readings were performed, what grading was used, etc. They need to describe what they mean by "semi-occluded". (major) Being a web based publication it may be accessed by individuals with very little knowledge of patch testing so this need to be described in full.

ii) I would find it useful (and as space is not an issue), if they included a table of the epoxy series they used (include chemical name, concentration + vehicle and result at D3 and D7). (minor)

iii) It would be nice if those references which have an http address, if these could be included. (minor)

3. Does the manuscript adhere to the relevant standards for reporting and data deposition: if not, in what ways?

Yes

4. Is the writing acceptable?

Acceptable

Reviewer's report

Very good article, clearly written and of interest to dermatologists and occupational health physicians. Worthy of publication.

Level of interest

A paper whose findings are important to those with closely related research interests (this would include most dermatologists)

Quality of written English

Acceptable