Acta derm.-venereol. 49: 547–551, 1969

ALLERGIC CONTACT DERMATITIS CAUSED BY PAPER

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Allergic contact dermatitis caused by paper has been described previously. This cause of contact dermatitis is, however, reported very rarely, as compared for example to chromates, nickel and formaldehyde. It is therefore believed that the frequency of paper dermatitis in the total population is relatively low and has been reported to represent 0.8 % of all occupational dermatitis. A study of 19 cases of paper dermatitis revealed several provoking substances *i.e.* metol, aniline, bichromate, paraphenylenediamine, melamine resin, 1-diethylamino-4 diazobenzene (4).

The risk of sensitization seems considerable in persons working with high speed duplicator papers of the diazo type. Responsible allergens have been reported to be azo dyes, hydroquinone, aniline dyes and the highly sensitizing substance p-tert.-butyl catechol.

Paper towels sometimes contain melamine resin to increase their resistance to water. By polymerization of dicyandiamine melamine is formed, which can then be combined with formaldehyde or urea formaldehyde to form melamine resin.

Carbon paper can also cause dermatitis of an allergic type. This applies less to the so called smudging type of carbon paper than to the "nonstaining" type of copying paper. The latter is used more and more *e.g.* in order books. The sensitizing substance is tricresyl phosphate (TCP) (2).

A steady demand for improvements in the quality of paper renders it likely that new active substances can be introduced into the manufacturing process. Such sensitizing property as these substances may possess is unlikely to manifest itself in the personnel in the industry in question, because of automated manufacturing processes. It is the consumers who can be expected to show eczematous reactions.

The paper consumption in a modern community is very extensive. Diagnosis of manifest paper allergy from case history alone can therefore be difficult. It is rather the clinical picture which will lead to suspicions of the cause of sensitization. Shape and function of articles concerned in the contact process will be reflected in the primary localization of a dermatitis. The same holds for the immediate, subsequent progression of the lesions. Very soon, however, secondary factors begin to play a role and can completely confuse the picture which may present itself as an iterotraumatic dermatitis of the housewife's dermatitis type. The original cause can therefore easily be overlooked.

The author's experience indicates that a certain type of allergic contact dermatitis caused by typing paper may well occur more frequently than reflected by a study of the literature.

Report on the Original Case

An office worker and housewife, 30 years old, previously free from skin diseases and allergic conditions had skin lesions localized

Read before the Meeting of Swedish Dermatological Society, April 20, 1968.

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Table 1. *Routine tests in investigation of contact dermatitis*

Formaldehyde	3 % aq. dest.
Quinine hydrochloride	1 % aq. dest.
Potassium bichromate	1/2 % aq. dest.
Mercuric chloride	0.1 % aq. dest.
Nickel sulphate	4 % aq. dest.
Turpentine	10 % o.o.
Colophony	20 % ethanol
Epoxy	1 % acetone
Neomycin	20 % aq. dest.
Benzocain	1 % aq. purif.
Procaine	1 % aq. purif.
Hexamethylene tetramine	1 % vas. alb.
Mercaptobenzothiazol	1 % vas. alb.
p-Phenylene diamine	1 % vas. alb.
Balsam of Peru	25 % vas. alb.
Juniper tar	5 % vas. alb.
Tetramethyl tiuram disulphide	1 % vas. alb.
Styrax	2 % vas. alb.

to the outer phalanges of the fingers, both on the volar and dorsal aspects and to some extent on the volar aspect of the outer phalanx of the thumb. The history gave no direct indications as to the provocing cause. The patient considered that the lesions were clearly related to water and detergents.

On the primary investigation by means of standard epicutaneous tests (Table 1) there were papular reactions to colophony, styrax and juniper tar. The relationship between these test reactions and the eczematous symptoms remained obscure for some time. The etiological association between the dermatitis and the patient's work with typing paper was based entirely on the distribution of the dermatitis. She folded typing paper and placed it both in envelopes and in plastic files of the pvc type. During a period when she was not doing this type of work, the correctness of our assumption was verified by provocation tests.

Further investigation comprised tests with the actual papers used as well as with the types of size used in the manufacture of the papers, based on pine resin or gum resin. In addition, test were performed with acids present in the resins, including abietic acid.[1] Finally the patient was tested with mixtures of resin acids in the following compositions:[2]

A. a native mixture containing sandaracopimaric acid (45 %), levopimaric acid (3 %), abietic acid (41 %) neoabietic acid (6 %) and dehydroabietic acid (4 %),
B. a purified pine resin fraction consisting of pimaric acid (3 %), abietic acid (47 %), palustric acid (10 %), dehydroabietic acid (35 %) and fatty acids (5 %),
C. a native mixture from spruce resin containing $\Delta^{8(9)-}$ isopimaric acid (1 %), pimaric acid (0.3 %), sandaracopimaric acid (2.9 %), levopimaric—palustric acids (65 %), dehydroabietic acid (15.5 %), abietic acid (6.4 %) and neoabietic acid (7.2 %).

Results

Table 2 shows how the suspected papers gave distinct eczematous reactions on test-

Table 2. *Results of tests with the papers concerned, with the size they contained and with acids contained in the size*

(+ redness; + + redness with papulae; + + + redness with vesicles)	
1. 'Monthly report'	neg
2. 'Renting out scheme' (G)	+ +
Resin size	neg
Pine resin 25 % in acetone	neg
3. White paper which had gone through a stencil (P)	+
4. White paper (P)	+ + +
Resin size	neg
Pine resin 25 % in acetone	neg
5. Typing paper (K)	+ + +
Paper size (K)	+ + +
Colophony 20 % in ethanol	+ + +
Abietic acid 1 % in aq. dest.	+ + +
Mixture A 1 % aq. dest.	+ +
Mixture B 1 % aq. dest.	+ +
Mixture C 1 % aq. dest.	neg

[1] Kebo 1.5849.

[2] These mixtures were kindly placed at the author's disposal by Professor Torbjörn Norin, Svenska Träforskningsinstitutet, Stockholm, Sweden.

Table 3. *The frequency of positive tests in 45 patients with contact dermatitis*

Allergen	No. of pos. tests
Balsam of Peru	12
Juniper tar	12
Colophony	10
Paper size (K)	9
Paraphenylene diamine	8
Styrax	7
Formaldehyde	6
Pine resin (contained in resinous size)	5
Abietic acid	3
Rubber chemicals	3
Epoxy	2
Mercury	2
Tricresyl phosphate	1
Nivea cream® *	1
Potassium bichromate	1
Nickel	1
Neomycin	1
Turpentine	0

* a sunscreen preparation

ing. It was apparent that the allergen was to be sought in the size used in the paper manufacture.

Were the positive reactions to resin size and resin acids due to an allergy or to a primary toxic effect?

A total of 130 consecutive patients with eczema were tested. The test substances comprised all allergens used in standard test (Table 1) and in addition pine resin, paper size (K), colophony and abietic acid. Four patients were also tested with paper (K) and three patients with the mixtures A, B and C of resin acids.

Results

Of the 130 patients 45 reacted to a varying number of test substances. The number of positive reactions for the respective substances are given in Table 3. It is evident that the allergens most frequently reported in previous years, *i.e.* chromate, nickel, formaldehyde, turpentine etc., were clearly less frequent than balsam of Peru, juniper tar and colophony. Paper size (K) also gave positive reactions, the frequency for this substance being close to that for colophony.

In Table 4 the sensitivity to colophony is related to the other positive tests. In this table 4 persons are presented who were also tested with paper (K). These latter tests were added when it had been found that the patients reacted to the combination of colophony, paper size (K) and juniper tar.

The table shows how almost all patients who reacted to colophony also reacted to paper size (K). The sensitivity to colophony also seemed to be associated with

Table 4. *The relation between a positive test for colophony and other positive tests*

	m	m	m	m	f	f	f	f	f	f
Colophony	+ +	+ +	+ + +	+ +	+ +	+	+ +	+ + +	+ + +	+ +
Paper size (K)	+ + +	+ +	+ + +	+ + +	o	o	+ +	+ + +	+ + +	+ +
Paper (K)	+ +			+ +				+ +		+
Styrax	+ + +	+ +	+ + +	+ +	o	o	o	+ + +	o	o
Juniper tar	+ +	+	+ + +	o	o	+ +	o	+ + +	o	+
Balsam of Peru	o	+ +	+	o	o	o	o	o	+ + +	o
Abietic acid	+	o	o	+ +	o	o	o	+ + +	+ + +	o
Pine resin	o	o	+ +	o	o	o	o	o	o	+
Formaldehyde	+ +	+ +	o	o	o	o	o	o	o	
Nivea cream					+ +					
Native mixture A				+ + +				+ +		+
Pine resin fraction B				+				+ +		+
Native mixture Spruce resin C				+ + +				o		o

o no reaction; + redness; + + redness with papulae; + + + redness with vesicles.

sensitivity to juniper tar (6/10) and to styrax (5/10). Sensitivity to the combination of colophony and paper size (K) was accompanied by a reaction to juniper tar and to styrax (5/8).

Four persons were tested secondarily with paper (K), with positive results. Three of them also reacted to abietic acid.

Some difficulties were encountered. Only three of the patients with positive reactions to paper (K) were tested with the mixtures A, B and C. The mixtures A and B gave positive reactions in all of them, and the mixture C only in one patient.

Discussion

Paper pulp is obtained mainly from pine trees. This pulp undergoes many processes of purification, during which tar, oils and resins are separated. To the increasingly refined pulp, different chemicals are then added according to the intended use of the finished product. For example, typing and drawing paper are sized. Dermatitis can occur in this industry, and it has been considered to be a primary toxic effect of alkalis, calcium bisulphite, sodium hydroxide, etc. Allergic dermatitis has also been reported, and the provocative agents in these cases have been pine tar, colophony or essential oils (5).

When paper pulp is treated with size, this latter is added in the ratio of 1 : 100. Some 90 % of the size consists of resin acids in simplified form. It also contains alun, which together with the resins forms a resinate with a positive charge. This facilitates fixation of the size to the fibres. The size can either be a so called "free resin size" or a resin soap size. In the latter case it is melted together with sodium hydroxide.

The resins occurring in paper are either of the "pine resin" or the "gum resin" type. Gum resin is obtained from living trees of the Pinis family. In Europe Pinus maritima and Pinus halepensis are found. The composition of the gums from these pine trees can vary. As a mean composition the following has been given (3): neutral part 10 %, abietic acid 53 %, dihydroabietic acid 11 %, tetrahydroabietic acid 18 %, dehydroabietic acid 3 %, $NaHCO_3$-dissolved, oxidized acids 5 %.

Gum resin is treated relatively mildly compared with pine resin. The latter is a resin fraction purified of fatty acids. Under severe thermic and chemical conditions the acids in the resin are considerably modified. In this process the quantities of dihydroabietic acid and dehydroabietic acid increase.

In the present study the original case was investigated with respect to contact sensitivity to different types of paper. It is remarkable that unequivocal reactions occurred to three different types of paper, but only to one type of paper size. This size is called paper size (K) and is prepared from a gum resin, containing colophony. The size of the other types of paper gave no reaction. One possible explanation is that these latter papers were contaminated with resin acids from the size containing colophony. This may have taken place by very close contact between the different types of paper. This would be analogous to observations on experimental studies of animals which have shown that small quantities of resin acids can be transferred from paper to articles packed in it, *e.g.* food substances (1).

The relationship between sensitivity to paper (K) and its size, on the one hand, and colophony, juniper tar and styrax, on the other hand, is striking. The detailed structure of the allergen cannot at present be stated with certainty. Abietic acid occurs, however, in a very high content in so called gum resin. In at least two patients with positive results in the paper test, reactions to abietic acid were also observed. In the remaining 128 patients, on the other hand, no reactions to abietic acid occurred. It therefore seems justified to assume that in these two cases there were allergic reactions to abietic acid. Primary toxic reactions can be excluded.

The three mixtures of different resin acids also gave positive test reactions in two patients with sensitivity to paper. These reactions may be regarded preliminarily as being provoked by the abietic acid

in the mixtures. It would be of value, however, to investigate the possibility of reactivity to the separate acids, possibly differentiated by chromatography. It would also be of interest to attempt to disintegrate the paper in question, and try to identify the occurrence of previously demonstrated reactive acids.

SUMMARY

Dermatitis on the hands of a young woman was investigated. An allergy to the typing paper used at her place of work was found. The allergen appeared to occur in the size contained in the paper, a gum resin which consisted partly of colophony.

Sensitivity to the typewriting paper mentioned appears to be accompanied also by sensitivity to colophony, juniper tar and styrax. All of these substances contain mixtures of resinous acids, one of which is abietic acid. Allergic recations to abietic acid were shown in sensitivity to typewriting paper.

Received for publication: Febr. 19, 1969.

The occurrence of such sensitivity was investigated within a relatively small population. In 3 out of 130 patients with eczema, the provocative cause could be traced to work with such paper.

REFERENCES

1. Davison, R. W., Kangas, L. R., Miller, R. M. and Watkins, S. H.: Migration of Rosin Components from Sized Paper to Exposed Foods. *TAPPI 48:* 433, 1965.
2. Hjort, N.: Contact Dermatitis from Cellulose Acetate Film. *Berufsdermatosen 12:* 86, 1964.
3. Personal Communication, Prof. T. Norin, quoted *Wood Chemistry, Vol. 1*, p. 607, Reinhold Publishing Corporation, New York, 1952.
4. Menigini, C. L., Rantuccio, F. and Riboldi, A.: Klinisch-allergische Beobachtungen bei beruflichen ekzematösen Kontakt-Dermatosen. *Berufsdermatosen 11:* 284, 1963.
5. Schwartz, L., Tulipan, L. and Birmingham, D. J.: *Occupational Diseases of the Skin*, p. 886, Philadelphia, 1957.