

Photopatch Testing of 182 Patients: A 6-Year Experience at the Mayo Clinic

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Background: Photopatch testing is important for diagnosing photoallergic contact dermatitis. Although results of photopatch testing have been presented from many European centers, there have been few reports of the results of photopatch testing in the United States.

Objective: To review the Mayo Clinic's recent experience with photopatch testing, identify common photoallergens, and compare our current and previous findings.

Methods: We retrospectively reviewed records of patients who underwent photopatch testing at the Mayo Clinic between January 1, 2000, and December 31, 2005 ($N = 182$).

Results: Fifty-four patients (29.7%) had photoallergic contact reactions, and 29 (15.9%) had allergic contact reactions. The most common photoallergens were medications, sunscreen agents, fragrances, and antiseptics.

Conclusion: Photopatch testing is the technique useful in identifying photoallergens. The series of allergens used must be constantly updated to reflect newly identified and outdated photoallergens. We present a 6-year experience with photopatch testing. Medications, sunscreen agents, fragrances, and antiseptics were the most frequently identified photoallergens.

PHOTOPATCH TESTING is an important tool for diagnosing patients with suspected photosensitivity, and it is the only method used to diagnose photoallergic contact dermatitis. The incidence of photoallergic contact dermatitis (PACD) likely is underestimated because (1) PACD may not be clinically suspected, (2) photopatch testing may not be readily available, and (3) the substances that cause PACD are diverse.¹ Furthermore, a recent survey of American Contact Dermatitis Society members showed that only 65% perform photopatch testing²; the percentage of general dermatologists who conduct photopatch testing is lower still.

Large studies of the results of photopatch testing have been conducted at numerous European centers. Photopatch testing of 1,155 patients in the United Kingdom with sunscreen agents was reported by Bryden and colleagues,³ and a French study with results from 2,067 patients was reported by Leonard and colleagues.⁴ However, few reports of photopatch testing from the

United States have been published.^{5,6} The photopatch test results from the Mayo Clinic (1980–1985) were reported previously.⁷ Since that time, new allergens have been added to our test series. To identify new trends in photoallergens, we report the photopatch-test results of patients tested over the subsequent 6-year period, from 2000 to 2005, 20 years from our previous report.

Methods

Patients

Patients who underwent photopatch testing for suspected photodermatitis at the Mayo Clinic (Rochester, Minnesota; Scottsdale, Arizona; and Jacksonville, Florida) from January 1, 2000, through December 31, 2005, were identified from a clinical database. This identification included patients with suspected photodermatoses and those with suspected allergic responses to sunscreen products. In general, patients did not undergo photopatch testing if they had applied topical corticosteroids to patch-test sites, had taken immunosuppressive medication (including oral corticosteroids), or had medical conditions that could compromise the evaluation of skin responsiveness. Four patients who denied research authorization were excluded from the analysis. This study was approved by the Mayo Clinic Institutional Review Board.

Patient demographics and photopatch-test results were abstracted from the clinical database. During the study

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period, 182 patients underwent duplicate photopatch tests with up to 34 allergens. One set of allergens was exposed to ultraviolet A (UVA) light; the duplicate set was not exposed.

Photopatch-Test Protocol

The protocol for photopatch testing has changed with time. Changes to the protocol or the allergens used in the series are made periodically by consensus of the Mayo Clinic Contact Dermatitis Group (MCCDG).

Test substances were placed in Finn Chambers (Allerderm Laboratories Inc, Petaluma, CA) mounted on Scanpor tape (Norgesplaster Aksjeselskap, Vennesla, Norway) and applied to the patient's back in duplicate sets, one on each side. Both sets of Scanpor tape were labeled with a skin-marking pen. The patient was instructed to wear photoprotective clothing and avoid sun exposure. After 24 hours (day 2), patches were removed from one side of the back, and the skin was exposed to UVA light. The rest of the patient's body was shielded from the light source. After illumination of one side, the patches were removed, and blank Finn Chambers were applied to the exact sites. After 48 hours (day 3), both sets of patches were removed, and the patch-test reactions were evaluated 15 to 20 minutes later (time was needed for any erythema to resolve). A subsequent reading was recorded on day 5. After evaluation, the patient received instructions on how to avoid the allergens that induced positive reactions.

The dose we use for UVA light exposure has changed. Until 2003, the dose was 1 J/cm² for all patients. In January 2003, the UVA dose was determined after performing a minimal erythema dose (MED) test before or on the day of patch application; tests were conducted with 5 J/cm² and 10 J/cm² of UVA light. If the patient's MED reaction occurred with less than 10 J/cm², the photopatch-test illumination dose was 5 J/cm². If the patient did not react to 10 J/cm² (ie, no positive MED reading), the default dose was 10 J/cm².

Grading of Photopatch-Test Reactions

Photopatch-test reactions were categorized as follows: negative reaction, macular erythema, weak reaction (non-vesicular erythema, infiltration, and possibly papules), strong reaction (edematous or vesicular), extreme reaction (spreading bullous ulcerative lesions), and photoirritant reaction. A positive allergic patch-test result was defined as erythema or as a weak, strong, or extreme reaction; macular erythema was categorized as a positive reaction if the result was relevant. Irritant reactions were excluded.

Interpretation of Photopatch-Test Reactions

Photopatch-test results were interpreted as follows: negative (negative results for the control and lighted sides); photoallergic (negative for the control side, positive for the lighted side); allergic contact (positive for the control side, positive for the lighted side); and photoirritant. A photoirritant reaction consisted of a positive reading on day 3 followed by a negative reading on day 5. This response would be considered a decrescendo (photo-toxic) reaction by Neumann and colleagues.⁸ All positive allergic patch-test reactions (including macular erythema) were further categorized as relevant or irrelevant on the basis of a history of known contact with substances containing the allergen or a history of circumstances of likely contact with substances containing the allergen.

If the reaction was positive at the irradiated site and at the covered site, it was recorded as allergic contact dermatitis (ACD). If the reaction was positive only at the irradiated site, it was recorded as PACD. Relevancy for each reaction was recorded as follows: I, irritant; N, allergic and not relevant (no exposure to products that contain the allergen); Q, allergic and questionably relevant (current exposure to products likely to contain the allergen); P, allergic and formerly relevant (past exposure to products likely to contain the allergen); and R, allergic and relevant (the result of the patch test with the product containing the allergen is positive, or the ingredient is verified in the patient's product and the use of that product is verified). For this study, a positive allergic patch-test result was defined as a weak, strong, or extreme reaction at the last reading or as a macular erythema reaction if the result was relevant after irritant reactions were excluded.

Results

Our screening series contained up to 34 allergens. From January 1, 2000, through December 31, 2005, 182 patients (114 females and 68 males) were tested. The mean age at the first visit was 53.7 years (range, 15–89 years).

Table 1 shows all allergens tested, test reactions, and relevancy of reactions; 54 patients (29.7%) had positive photoallergic contact reactions, and 29 (15.9%) had allergic contact reactions. Table 2 compares the test results from 2000 through 2005 with the results of a similar screen performed at the Mayo Clinic from 1980 through 1985.⁷ Chlorpromazine and promethazine continue to have high reaction rates whereas the reaction rate for musk ambrette has decreased. Table 3 outlines our current photopatch-test allergen series.

Table 1. Reactions to Allergens in Photopatch Test Series

Photoallergen*	Tests Performed	Irritant Contact Reactions		Allergic Contact Reactions		Relevant Allergic Contact Reactions		Photoirritant Reactions		Photoallergic Contact Reactions†		Relevant Photoallergic Contact Reactions
		No.	%	No.	%	Contact Reactions	%	No.	%	No.	%	Contact Reactions
Fenticlor (thiobis-chlorophenol) 1%	177	2	1.1	2	1.1	0	0	1	0.6	16	9.0	4
Chlorpromazine HCl 0.1%	177	0	0.0	2	1.1	1	1	1	0.6	13	7.3	2
Promethazine HCl 1%	177	0	0.0	2	1.1	1	1	2	1.1	13	7.3	3
Benzophenone-4 (sulisobenzene) 10%	178	0	0.0	6	3.4	1	1	0	0.0	8	4.5	5
2-Hydroxy-4-methoxybenzophenone 3%	178	3	1.7	3	1.7	2	2	0	0.0	5	2.8	4
4-Aminobenzoic acid 10%	141	0	0.0	1	0.7	0	0	0	0.0	4	2.8	1
Tetrachlorosalicylanilide 0.1%	179	3	1.7	1	0.6	0	0	0	0.0	4	2.2	2
Bithionol (thiobis-dichlorophenol) 1%	149	0	0.0	1	0.7	0	0	0	0.0	3	2.0	0
2-Ethylhexyl 4-methoxycinnamate 10%	157	0	0.0	3	1.9	1	1	1	0.6	3	1.9	2
Sandalwood oil 2%	178	0	0.0	2	1.1	1	1	0	0.0	3	1.7	0
Hexachlorophene 1%	177	3	1.7	3	1.7	1	1	3	1.7	3	1.7	2
Chlorhexidine diacetate 0.5% (aqueous)	178	0	0.0	1	0.6	0	0	1	0.6	3	1.7	2
2-Ethylhexyl 4-dimethylaminobenzoate 5% (in alcohol)	178	2	1.1	1	0.6	0	0	2	1.1	3	1.7	3
3-(4'-Methylbenzylidene)-camphor 10%	177	1	0.6	0	0.0	0	0	0	0.0	3	1.7	1
4-tert-Butyl-4'-methoxydibenzoylmethane 5%	156	0	0.0	0	0.0	0	0	0	0.0	2	1.3	1
Triclosan 2%	174	0	0.0	1	0.6	0	0	1	0.6	2	1.1	1
Octyl salicylate 5%	176	1	0.6	3	1.7	2	2	2	1.1	2	1.1	1
4-Aminobenzoic acid 5% (in alcohol)	178	1	0.6	2	1.1	1	1	0	0.0	2	1.1	1
Petrolatum 100%	178	0	0.0	1	0.6	0	0	1	0.6	2	1.1	1
3,4,5-Tribromosalicylanilide 1%	179	0	0.0	1	0.6	0	0	0	0.0	2	1.1	2
Methylanthranilate 5%	177	0	0.0	0	0.0	0	0	0	0.0	2	1.1	0
Diphenhydramine HCl 1%	178	1	0.6	0	0.0	0	0	3	1.7	2	1.1	1
Sesquiterpene lactone mix 0.1%	178	1	0.6	4	2.2	3	3	1	0.6	1	0.6	1
6-Methylcoumarin 1% (in alcohol)	176	1	0.6	3	1.7	2	2	0	0.0	1	0.6	0
Dichlorophene 1%	178	0	0.0	3	1.7	2	2	1	0.6	1	0.6	0
2-Ethylhexyl 4-dimethylaminobenzoate 5%	178	0	0.0	2	1.1	1	1	1	0.6	1	0.6	0
2-Phenylbenzimidazole-5-sulfonic acid 10%	177	0	0.0	0	0.0	0	0	0	0.0	1	0.6	1
Sulfanilamide 5%	177	0	0.0	0	0.0	0	0	0	0.0	1	0.6	0
Homomenthylsalicylate (homosalate) 5%	178	0	0.0	1	0.6	0	0	0	0.0	1	0.6	0
3,4,4-Trichlorocarbanilide (triclocarban) 1%	179	0	0.0	1	0.6	1	1	1	0.6	1	0.6	1

Table 1. Continued

Photoallergen*	Tests Performed	Irritant Contact Reactions		Allergic Contact Reactions		Relevant Allergic Contact Reactions		Photoirritant Reactions		Photoallergic Contact Reactions†		Relevant Photoallergic Contact Reactions	
		No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Chlorothiazide 1%	127	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Musk ambrette 1%	46	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
4-Aminobenzoic acid 5%	35	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Thiourea 0.1%	178	0	0.0	1	0.6	0	0.0	1	0.6	0	0.0	0	0.0

*All allergens are in petrolatum unless otherwise indicated.

†Ordered by the percentage of reactions.

Discussion

PACD often goes unrecognized because photopatch testing often is not performed. Photopatch testing is an essential tool in the diagnosis of PACD, but there is confusion about how best to perform the photopatch tests and which allergens to use. Many protocols for photopatch testing have been described,³ and various allergens have been used. Comparing data across studies is difficult because of differences in methodology.

Herein we describe photopatch-test results at the Mayo Clinic during a 6-year period. Our method of photopatch testing has not changed considerably in the past 20 years, but we now use different UVA irradiation dosages. Some allergens in the series are no longer used, and new allergens are now included.

The sensitivity and specificity of our photopatch-test procedure is difficult to ascertain because no diagnostic standard is available for comparison. Different centers use different techniques for photopatch testing; ultimately, the goal is to determine whether the patient improves after avoiding identified photoallergens.

Comparison with Previously Reported Studies

Our study is small when compared with the European studies published during the past several decades; select previous reports are presented in Table 4.^{2,4,6-12} The percentage of photoallergic reactions in our series is higher than that in other studies but similar to that reported by Leonard and colleagues.⁴ In common with other reported series, the most frequent causes of photoallergic reactions in our study were topically applied medications, sunscreen agents, antiseptics, and certain fragrances. It is evident from our experience and that of others that the chemicals that cause photoallergic reactions are in flux because identified photoallergens are removed from the market and other photoallergens are introduced. For example, sunscreens are now one of the most common causes of photoallergy whereas fragrance allergens are less prevalent now that one of the main culprits (musk ambrette) is no longer used. Furthermore, the types of topically applied medications that cause photoallergy have changed: ketoprofen has recently become a common photoallergen whereas topically applied fenticlor, chlorpromazine, and chlorothiazide are now rare.

Photopatch-Testing Protocol

Controversies exist about UVA doses, the timing of UVA exposures, and the methods used to read and interpret

Table 2. Comparison of Reactions to Photoallergens in the 1980–1985 and 2000–2005 Study Periods

Photoallergen	Concentration and Vehicle	Photoallergic Contact Reactions			
		1980–1985 ⁷		2000–2005	
		No.	% [*]	No.	% [*]
Fenticlor (thiobis-chlorophenol)	1% pet	5	7.1	16	9.0
Chlorpromazine HCl	0.1% pet	TADC	TADC	13	7.3
Chlorpromazine HCl	1% pet	13	18.6	TADC	TADC
Promethazine HCl	1% pet	TADC	TADC	13	7.3
Promethazine HCl	2% pet	8	11.4	TADC	TADC
Benzophenone-4 (sulisobenzone)	10% pet	2	2.9	8	4.5
Benzophenone-4 (sulisobenzone)	5% pet	1	1.4	NT	NT
2-Hydroxy-4-methoxybenzophenone	3% pet	NT	NT	5	2.8
4-Aminobenzoic acid	10% pet	TADC	TADC	4	2.8
4-Aminobenzoic acid	5% pet	TADC	TADC	0	0.0
4-Aminobenzoic acid	5% alc	TADC	TADC	2	1.1
4-Aminobenzoic acid	10% alc	1	1.4	TADC	TADC
Tetrachlorosalicylanilide	0.1% pet	TADC	TADC	4	2.2
3,3,4,5-Tetrachlorosalicylanilide	1% pet	3	4.3	TADC	TADC
Bithionol (thiobis-dichlorophenol)	1% pet	3	4.3	3	2.0
2-Ethylhexyl 4-methoxycinnamate	7.5% pet	TADC	TADC	3	1.9
Cinnamate	5% pet	0	0.0	TADC	TADC
2-Ethylhexyl 4-dimethylaminobenzoate	5% alc	NT	NT	3	1.7
2-Ethylhexyl 4-dimethylaminobenzoate	5% pet	NT	NT	1	0.6
3-(4'-Methylbenzylidene)-camphor	10% pet	NT	NT	3	1.7
Chlorhexidine diacetate	0.5% aq	NT	NT	3	1.7
Hexachlorophene	1% pet	4	5.7	3	1.7
Sandalwood oil	2% pet	NT	NT	3	1.7
4- <i>tert</i> -Butyl-4'-methoxydibenzoylmethane	5% pet	NT	NT	2	1.3
3,4,5-Tribromosalicylanilide	1% pet	2	2.9	2	1.1
Diphenhydramine HCl	1% pet	NT	NT	2	1.1
Methylantranilate	5% pet	NT	NT	2	1.1
Octyl salicylate	5% pet	NT	NT	2	1.1
Petrolatum	100% pet	NT	NT	2	1.1
Triclosan	2% pet	NT	NT	2	1.1
2-Phenylbenzimidazole-5-sulfonic acid	10% pet	NT	NT	1	0.6
3,4,4-Trichlorocarbanilide (triclocarban)	1% pet	2	2.9	1	0.6
6-Methylcoumarin	1% alc	TADC	TADC	1	0.6
6-Methylcoumarin	5% pet	5	7.1	TADC	TADC
Dichlorophene	1% pet	2	2.9	1	0.6
Homomenthylsalicylate (homosalate)	5% pet	TADC	TADC	1	0.6
Homomenthylsalicylate (homosalate)	2% pet	2	2.9	TADC	TADC
Sesquiterpene lactone mix	0.1% pet	NT	NT	1	0.6
Sulfanilamide	5% pet	NT	NT	1	0.6
Chlorothiazide	1% pet	NT	NT	0	0.0
Musk ambrette	1% alc	TADC	TADC	0	0.0
Musk ambrette	5% alc	9	12.9	TADC	TADC
Thiourea	0.1% pet	NT	NT	0	0.0
Amyl-4-dimethylaminobenzoate	5% pet	2	2.9	NT	NT
Bergamot	5% pet	3	4.3	NT	NT
<i>Chrysanthemum</i> oleoresin	1:10% alc	1	1.4	NT	NT
Diphenylphenol	2% pet	2	2.9	NT	NT

Table 2. Continued

Photoallergen	Concentration and Vehicle	Photoallergic Contact Reactions			
		1980–1985 ⁷		2000–2005	
		No.	%*	No.	%*
Quinine	1% pet	3	4.3	NT	NT
Ragweed	—	3	4.3	NT	NT

alc = alcohol; aq = aqueous; HCl = hydrochloride; NT = not tested; pet = petrolatum; TADC = tested in a different concentration/vehicle.

*Percentages were calculated after assuming that all 70 patients were tested.

patch-test results. Our protocol for UVA exposure was changed in 2003 because we noted that our previous dosage (1 J/cm²) was lower than that reported by other institutions; this lower exposure theoretically might not have allowed sufficient allergen photoactivation. We now use the MED protocol as previously described. Because

reactions to the MED protocol may require 48 hours to develop, we prefer to perform the MED tests before we perform the photopatch tests. Before 2003, we observed 35 photoallergic reactions among 85 patients (an average of 0.41 reactions per patient); since implementation of the new MED protocol and UVA dosage in 2003, we have observed 73 reactions among 97 patients (an average of 0.75 reactions per patient). The higher UVA dose seemed to induce more photoallergic reactions.

A specific period between allergen application and irradiation is not accepted universally. Our protocol uses a 24-hour interval between application and irradiation, but a recent study by Batchelor and Wilkinson showed that irradiation after 48 hours resulted in a greater number of photoallergic reactions.¹³

Interpretation of photopatch-test results may be challenging. We observed 23 reactions among 15 patients that were positive on the control (unlighted) side and negative on the lighted side; these reactions are difficult to explain. We did not look for the “photoaugmented” reactions (positive reactions on the control and lighted sides that were more prominent on the lighted side) described by Bryden and colleagues.³

Grading Relevance

The relevance of allergic patch-test results is always difficult to estimate. We included allergens with definite relevance in the tables. However, many additional allergic patch-test reactions were adjudged to be of possible relevance (data not shown).

Common Allergens

Medications

Fenticlor, chlorpromazine, chlorothiazide, and sulfanilamide were the substances in our photopatch test series that

Table 3. Allergens in the Current Photopatch Test Series

2-Ethylhexyl 4-methoxycinnamate 10%
Benzophenone-4 (sulisobenzene) 10%
Thiourea 0.1%
Dichlorophene 1%
3,4,4-Trichlorocarbaniide (triclocarban) 1%
Sulfanilamide 5%
Chlorhexidine diacetate 0.5% (aqueous)
Sandalwood oil 2%
4-Aminobenzoic acid 5% (in alcohol)
Petrolatum 100%
3,4,5-Tribromosalicylanilide 1%
2-Ethylhexyl 4-dimethylaminobenzoate 5%
2-Ethylhexyl 4-dimethylaminobenzoate 5% (in alcohol)
2-Phenylbenzimidazole-5-sulfonic acid 10%
Bithionol (thiobis-dichlorophenol) 1%
4-Aminobenzoic acid 10%
Octyl salicylate 5%
4-tert-Butyl-4'-methoxydibenzoylmethane 10%
Homomenthylsalicylate (homosalate) 5%
Methylantranilate 5%
6-Methylcoumarin 1% (in alcohol)
Musk ambrette 1%
Tetrachlorosalicylanilide 0.1%
Diphenhydramine HCl 1%
3-(4'-Methylbenzylidene)-camphor 10%
Hexachlorophene 1%
2-Hydroxy-4-methoxybenzophenone 3%
Triclosan 2%
Sesquiterpene lactone mix 0.1%
Ketoprofen 1%
Ketoprofen 5%

HCl = hydrochloride.

Table 4. Select Patch Test Series

<i>Series</i>	<i>Study Period</i>	<i>Country or Region</i>	<i>No. of Patients</i>	<i>Photoallergic Reactions (%)</i>	<i>Allergic Reactions (%)</i>	<i>Most Common Allergen Groups</i>
Menz et al ⁷	1980–1985	United States	70	38.5	31.0	Medications, fragrances
Thune et al ¹⁰	1980–1985	Scandinavia	1,993	11.0	10.0	Fragrances
Darvey et al ⁹	1983–1998	United Kingdom	2,715	2.3	Not specified	Ultraviolet filters, drugs, fragrances, antiseptics
Neumann et al ⁸	1985–1990; 1991–1997	Germany, Austria, Switzerland	1,129; 1,261	3.8; 8.1	28.6; 28.7	Nonsteroidal antiinflammatory drugs, disinfectants, phenothiazines
DeLeo et al ⁶	1985–1990	United States	187	11.0	Not specified	Fragrances, sunscreen agents
Leonard et al ⁴	1991–2001	France	2,067	39.7–60.0	29.5–45.6	Medications, sunscreen agents
Katsarou et al ¹¹	1992–2006	Greece	207	13.52	41.54	Medications, sunscreen agents
Bryden et al ²	2000–2002	United Kingdom, Ireland, the Netherlands	1,155	4.4	5.5	Sunscreen agents
Current study	2000–2005	United States	182	29.7	15.9	Medications, sunscreen agents, fragrances, antiseptics
Pigatto et al ¹²	2004–2006	Italy	1,082	19.0	6.0	Medications, organic ultraviolet filters, antimicrobial agents

yielded the most photoallergic reactions. They were previously used in topical medications but are now obsolete ingredients. Because they are no longer used in topical medications, they were recently deleted from our test series (subsequent to the years of this study). We report rates of reaction to these medications here because they were still in our series during the 6-year study period.

Sunscreen Agents

Sunscreen agents are recognized as the most common photoallergens in the United States and the United Kingdom.³ Sunscreen use is increasing worldwide as awareness of the importance of protecting skin from ultraviolet light increases. The protective agents used in sunscreens have changed over time, and these chemicals may be photoallergens.

Fragrances and Antiseptics

Musk ambrette is a synthetic fragrance used in colognes and aftershave lotions. Musk ambrette 1% was removed from our photopatch series in March 2001 because of diminished

commercial use in the United States. However, it was reinstated in January 2006 because we found that some patients still used products containing musk ambrette (typically purchased before 1994). Hexachlorophene and triclosan are commonly used wide-spectrum antiseptic agents that can cause rare photoallergic reactions.

Allergens in the Current Photopatch Test Series

Over time, the list of allergens used in our photopatch test series has been revised substantially; the current series is shown in Table 3. Topical medications known to cause photoallergies were removed from the series if they were obsolete (ie, no longer used in commercial topical products). The number of sunscreen agents has been increased because they are now the principal cause of observed photoallergies. We stopped testing with musk ambrette but reintroduced it after we recognized that patients could still be exposed to this allergen. We continue to test antiseptic agents because patients continue to be exposed to them.

Although no patients in our study had positive reactions to chlorothiazide, musk ambrette, 4-aminobenzoic acid 5%,

or thiourea, the MCCDG decided to keep them in the photopatch series. This decision was made on the basis of reactions reported in the literature and because topical exposure may occur for our patients. Testing uncommon allergens is worthwhile to identify the small percentage of patients who react to them.

After this study, we added ketoprofen to the series. Ketoprofen is a nonsteroidal antiinflammatory drug increasingly used in topical preparations because of its analgesic, antipyretic, and antiinflammatory properties. Many recent reports have described an association between ketoprofen and PACD.^{14–27} Derived from propionic acid, ketoprofen has structural similarities to benzophenone sunscreens.¹⁴

Limitations

Compared with the results of multicenter photopatch testing reported from Europe, the number of patients reported here is small. However, all patients reported here underwent patch testing at a single institution, and we are able to compare our results with those in our previous report⁷. The study has the limitations inherent in any retrospective study. Interclinician variability in the interpretation of the relevance of photopatch-test results is another limitation. Because the Mayo Clinic is a tertiary referral center, we do not have follow-up data on many patients and therefore cannot comment meaningfully on whether these photopatch-test results led to an improvement in the patients' conditions. Allergen series are in constant evolution; thus, our photopatch allergens varied during the study period. Our protocol has also evolved over time.

Conclusion

Photopatch testing is useful for patients with presumed photosensitivities, and the technique used to identify photoallergens has evolved. During our 6-year study period, 54 (29.7%) of 182 patients had photoallergic reactions to allergens in our series. Topically applied medications, sunscreen agents, fragrances, and antiseptics were the most frequently identified photoallergens.

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References

1. Goossens A. Photoallergic contact dermatitis. *Photodermatol Photoimmunol Photomed* 2004;20:121–5.
2. Warshaw EM, Moore JB, Nelson D. Patch-testing practices of American Contact Dermatitis Society members: a cross-sectional survey. *Am J Contact Dermat* 2003;14:5–11.
3. Bryden AM, Moseley H, Ibbotson SH, et al. Photopatch testing of 1155 patients: results of the U.K. Multicentre Photopatch Study Group. *Br J Dermatol* 2006;155:737–47.
4. Leonard F, Adamski H, Bonneville A, et al. [The prospective multicenter study on standard photopatch tests by the French Society of Photodermatology from 1991–2001]. *Ann Dermatol Venerol* 2005;132:313–20.
5. Kerr HA, Lim HW. Photodermatoses in African Americans: a retrospective analysis of 135 patients over a 7-year period. *J Am Acad Dermatol* 2007;57:638–43.
6. DeLeo VA, Suarez SM, Maso MJ. Photoallergic contact dermatitis. Results of photopatch testing in New York, 1985 to 1990. *Arch Dermatol* 1992;128:1513–8.
7. Menz J, Muller SA, Connolly SM. Photopatch testing: a six-year experience. *J Am Acad Dermatol* 1988;18:1044–7.
8. Neumann NJ, Holzle E, Plewig G, et al. Photopatch testing: the 12-year experience of the German, Austrian, and Swiss photopatch test group. *J Am Acad Dermatol* 2000;42:183–92.
9. Darvay A, White IR, Rycroft RJ, et al. Photoallergic contact dermatitis is uncommon. *Br J Dermatol* 2001;145:597–601.
10. Thune P, Jansen C, Wennersten G, et al. The Scandinavian multicenter photopatch study 1980–1985: final report. *Photodermatol* 1988;5:261–9.
11. Katsarou A, Makris M, Zarafonitis G, et al. Photoallergic contact dermatitis: the 15-year experience of a tertiary reference center in a sunny Mediterranean city. *Int J Immunopathol Pharmacol* 2008;21:725–8.
12. Pigatto PD, Guzzi G, Schena D, et al. Photopatch tests: an Italian multicentre study from 2004 to 2006. *Contact Dermatitis* 2008;59:103–8.
13. Batchelor RJ, Wilkinson SM. Photopatch testing: a retrospective review using the 1 day and 2 day irradiation protocols. *Contact Dermatitis* 2006;54:75–8.
14. Hindsen M, Zimerson E, Bruze M. Photoallergic contact dermatitis from ketoprofen in southern Sweden. *Contact Dermatitis* 2006;54:150–7.
15. Durbize E, Vigan M, Puzenat E, et al. Spectrum of cross-photosensitization in 18 consecutive patients with contact photoallergy to ketoprofen: associated photoallergies to non-benzophenone-containing molecules. *Contact Dermatitis* 2003;48:144–9.
16. Bosca F, Marin ML, Miranda MA. Photoreactivity of the nonsteroidal anti-inflammatory 2-arylpropionic acids with photosensitizing side effects. *Photochem Photobiol* 2001;74:637–55.
17. Lopez-Abad R, Paniagua MJ, Botey E, et al. Topical dexketoprofen as a cause of photocontact dermatitis. *J Invest Allergol Clin Immunol* 2004;14:247–9.
18. Matthieu L, Meuleman L, Van Hecke E, et al. Contact and photocontact allergy to ketoprofen: the Belgian experience. *Contact Dermatitis* 2004;50:238–41.
19. Hindsen M, Isaksson M, Persson L, et al. Photoallergic contact dermatitis from ketoprofen induced by drug-contaminated personal objects. *J Am Acad Dermatol* 2004;50:215–9.

-
20. Sugiyama M, Nakada T, Hosaka H, et al. Photocontact dermatitis to ketoprofen. *Am J Contact Dermat* 2001;12:180–1.
 21. Matsushita T, Kamide R. Five cases of photocontact dermatitis due to topical ketoprofen: photopatch testing and cross-reaction study. *Photodermatol Photoimmunol Photomed* 2001;17:26–31.
 22. Sugiura M, Hayakawa R, Kato Y, et al. 4 cases of photocontact dermatitis due to ketoprofen. *Contact Dermatitis* 2000;43:16–9.
 23. Albes B, Marguery MC, Schwarze HP, et al. Prolonged photosensitivity following contact photoallergy to ketoprofen. *Dermatology* 2000;201:171–4.
 24. Devleeschouwer V, Roelandts R, Garmyn M, Goossens A. Allergic and photoallergic contact dermatitis from ketoprofen: results of (photo) patch testing and follow-up of 42 patients. *Contact Dermatitis* 2008;58:159–66.
 25. Ota T, Oiso N, Iba Y, et al. Concomitant development of photoallergic contact dermatitis from ketoprofen and allergic contact dermatitis from menthol and rosin (colophony) in a compress. *Contact Dermatitis* 2007;56:47–8.
 26. Goiriz R, Delgado-Jimenez Y, Sanchez-Perez J, Garcia-Diez A. Photoallergic contact dermatitis from lavender oil in topical ketoprofen. *Contact Dermatitis* 2007;57:381–2.
 27. Diaz RL, Gardeazabal J, Manrique P, et al. Greater allergenicity of topical ketoprofen in contact dermatitis confirmed by use. *Contact Dermatitis* 2006;54:239–43.