

Photopatch testing in Bogota (Colombia): 2011–2013

Martha C. Valbuena Mesa and Elsa V. Hoyos Jiménez

Photodermatology Unit, Centro Dermatológico Federico Lleras Acosta (Colombian National Institute of Dermatology), 111511 Bogota D.C., Colombia

doi:10.1111/cod.12421

Summary

Background. Photopatch tests are used to diagnose photoallergic contact dermatitis and identify the causal agents. The frequencies of positive results and associated allergens vary by country; therefore, it is necessary to know the information specific to each country.

Objective. To establish the frequency of positive photopatch test results, and their relevance, in patients with suspected photoallergic contact dermatitis in a national dermatology centre located in Bogota, Colombia.

Materials and methods. One hundred patients investigated for possible photoallergic contact dermatitis were enrolled in the study. They were photopatch tested with a selected group of allergens, and occluded for 48 hours; the duplicate right-hand panel was irradiated with 5 J/cm² ultraviolet (UV)A. The readings were performed on D2, D4, and D6, in accordance with the guidelines of the ICDRG, and the relevance was evaluated with the COADEX system.

Results. There were a total of 20 photopatch reactions in 15 patients, 95% of which were caused by UV filters, most frequently benzophenone-3 (55%). Eight of the positive reactions (53.3%) appeared on D6.

Conclusions. UV filters continue to be the most common causes of photoallergic contact dermatitis in our patients. Readings up to D6 (96 hr after irradiation) are important to identify delayed positive reactions.

Key words: allergen; allergic contact dermatitis; photoallergic contact dermatitis; photopatch test.

Photoallergic contact dermatitis is an eczematous eruption on sun-exposed skin that occurs as a result of a type IV delayed hypersensitivity reaction when an exogenous photoallergen applied on the skin is exposed to the appropriate radiation, usually ultraviolet (UV)A radiation (1–3). Photopatch testing is the tool used for

diagnosing photoallergic contact dermatitis and identifying the causal agents (2, 4, 5).

Photopatch testing methodology varies between different centres and countries, although several attempts have been made to achieve standardization (3, 6–8). The consensus on standardization reached in Europe in 2004 (9) resulted in a protocol for photopatch testing that is currently used worldwide. However, several controversies still exist, mainly regarding allergen occlusion time (24 versus 48 hr) (10) and the need to perform the readings not only at 2 days but also at 4 days after irradiation (11).

The photopatch test allergens vary according to the chemical composition of the products available to the public. Therefore, the allergens tested must be updated periodically (2, 12, 13). In 2012, a series of allergens

Correspondence: Martha C. Valbuena Mesa, Avda. 1 No. 13A-61, 111511 Bogota D.C., Colombia. Tel: 57-1-2428160 ext. 145. E-mail: marvalbuen@yahoo.com

Funding: This work was funded by the Centro Dermatológico Federico Lleras Acosta, Bogota, Colombia.

Conflict of interest: The authors declare that there are no conflicts of interest.

Accepted for publication 22 April 2015

Table 1. Allergens used for photopatch testing

Allergen	Concentration (%) in petrolatum	CAS no.
Butyl methoxydibenzoylmethane	10	70356-09-1
4-Methylbenzylidene camphor	10	36861-47-9/38102-62-4
Ethylhexyl dimethyl PABA	10	21245-02-3
Benzophenone-3	10	131-57-7
Ethylhexyl methoxycinnamate	10	5466-77-3
Benzophenone-10	10	1641-17-4
Phenylbenzimidazole sulfonic acid	10	27503-81-7
Benzophenone-4	2	4065-45-6
Octocrylene	10	6197-30-4
Ethylhexyl salicylate	5	118-60-5
Ethylhexyl triazone	10	88122-99-0
Isoamyl- <i>p</i> -methoxycinnamate	10	71617-10-2
bis-Ethylhexyloxyphenol methoxyphenyl triazine	10	187393-00-6
Methylene bis-benzotriazolyl tetramethylbutylphenol (Tinosorb® M)	10	103597-45-1
Sesquiterpene lactone mix ^a	0.1	—
Triclosan	2	3380-34-5
Fragrance mix I ^b	8	—
3,4',5-Tribromosalicylanilide	10	87-10-5
Ketoprofen	1	22071-15-14
4-tert-Butyl-3-methoxy-2,6-dinitrotoluene (musk ambrette)	5	83-66-9

^aSesquiterpene lactone mix: alantolactone 0.033% (CAS no. 546-43-0); dehydrocostus lactone 0.033% (CAS no. 477-43-0); and costunolide 0.033% (CAS no. 553-21-9).

^bFragrance mix I: cinnamyl alcohol 1% (CAS no. 104-54-1); cinnamal 1% (CAS no. 104-55-2); hydroxycitronellal 1% (CAS no. 107-75-5); amyl cinnamal 1% (CAS no. 122-40-7); geraniol 1% (CAS no. 106-24-1); eugenol 1% (CAS no. 97-53-0); isoeugenol 1% (CAS no. 97-54-1); and *Evernia prunastri* extract 1% (CAS no. 90028-68-5).

were recommended for photopatch tests in Europe, which excluded several substances that are no longer in use or considered to be relevant to the European population (14); however these allergens could be in use in other countries.

Between 2001 and 2003, we conducted a study aimed at identifying the allergens responsible for photoallergic contact dermatitis in our population. We identified benzophenone-3 as the main cause of photoallergic contact dermatitis (15). Some photoallergens, such as musk ambrette and halogenated salicylanilides, were not included in the previous study, and new products with photosensitizing potential have been introduced to the market over time; this study evaluated the ability of a newly adapted photopatch test series to identify the causal agents of photoallergic contact dermatitis in suspected cases in our population.

Patients and Methods

A prospective, descriptive, cross-sectional study was conducted with 112 consecutive patients who visited the Centro Dermatológico Federico Lleras Acosta (Colombian National Institute of Dermatology) between June 2011 and June 2013. The inclusion criteria were as follows: dermatitis affecting mainly light-exposed skin, a history of a sunscreen skin reaction, or a topical non-steroidal

anti-inflammatory drug (NSAID) skin reaction. Patients with a clinical diagnosis of porphyria, solar urticaria or systemic lupus erythematosus were excluded from the testing procedure, as were pregnant woman (identified by clinical history), and patients who received systemic steroid treatments or immunosuppressive drugs in the month before the test or who applied topical steroids on their backs in the 8 days prior to the test. One hundred patients agreed to participate in the study, and all of them signed an informed consent form.

The average age of the participants was 49 years (13–88 years), with a standard deviation of 16.5 years; 63 patients were women and 37 were men. Eighty patients had a history of exposed-site dermatitis, and 20 had a history of sunscreen skin reaction; none reported allergy to NSAIDs.

Photopatch tests were performed on this group of patients, with the allergens shown in Table 1. Although fragrance mix I and sesquiterpene lactone mix are common contact allergens, we included them in the series because these substances can cause airborne contact dermatitis and simulate photoallergic contact dermatitis. The allergens were obtained from Chemotechnique Diagnostics (Vellinge, Sweden), except for musk ambrette, which was provided by Brial Allergen GmbH (Greven, Germany).

Photopatch tests were performed according to the European consensus methodology (9). On D0, the allergens were applied in duplicate to healthy skin in the paravertebral zone on the back of each patient in Finn Chambers®, and were covered with opaque tape. The skin with the allergens was covered up to D2, when the patches were removed. The left-hand allergen panel was covered with a UV radiation-opaque material, and the right-hand panel was irradiated with 5 J/cm² UVA light in a Daavlin phototherapy unit 305–350 calibrated with an IL-1700 research radiometer and a UVB sensor (International Light Technologies Inc., Peabody, MA, USA) with an irradiance of 9.2 J/cm², which provided a 320–400-nm spectrum. Two trained dermatologists read the tests on D2, D4 (48 hr after irradiation), and D6 (96 hr after irradiation). Reactions were evaluated in accordance with ICDRG recommendations. Reactions classified as photoallergic were positive only in the irradiated panel. Those that were positive in both panels were considered to be allergic contact reactions. If the reading of the irradiated panel was greater than that of the non-irradiated panel, the reaction was classified as photoexacerbation; in the opposite case, the reaction was classified as photoinhibition. Irritant reactions were those with a decrescendo pattern, present in one or both panels. The relevance of the results was evaluated with the COADEX system, in which C corresponds to current relevance, O to old or past relevance, A to an active sensitization reaction, D to doubtful or unknown relevance, E to a history of exposure not resulting in an allergic reaction, and X to a cross-reaction with other allergen (11). All patients were advised to contact the clinic if they noticed any skin reaction after D6.

All of the procedures performed throughout the course of this study were previously approved by the institutional ethical committee, and followed all of the Helsinki Declaration recommendations.

In the analysis of the results, quantitative measures of central tendency and dispersion were used, and, for qualitative variables, proportions were used.

Results

Forty-one patients showed photopatch or patch reactions to one or more allergens; 23 (56%) were women and 18 (44%) were men. The average age was 47.6 years. Five patients (4 women and 1 man) showed both photopatch and patch test reactions to different allergens.

Photoallergic contact dermatitis reactions

Fifteen of the 100 patients, 9 (60%) women and 6 (40%) men, with a mean age of 48 years, showed positive

Table 2. Allergens responsible for photoallergic contact reactions and their relevance (COADEX system)

Allergen in petrolatum	Frequency	%	C	D	O
Benzophenone-3 (10%)	11	55	3	7	1
Ethylhexyl methoxycinnamate (10%)	2	10	1	1	0
Butyl methoxydibenzoylmethane (10%)	1	5	1	0	0
Benzophenone-10 (10%)	1	5	0	1	0
Benzophenone-4 (2%)	1	5	0	1	0
Ethylhexyl salicylate (5%)	1	5	0	1	0
Isoamyl- <i>p</i> -methoxycinnamate (10%)	1	5	1	0	0
Tinosorb® M (10%)	1	5	1	0	0
3,4',5-Tribromosalicylanilide (10%)	1	5	1	0	0
Total	20	100	8	11	1

C, current; D, doubtful/unknown; O, old.

Table 3. Positive photopatch test reactions (PPTRs) on D4/D6 and on D6 only

Allergen in petrolatum	Positive PPTR registered on D4	Positive PPTR registered on D6 only
Benzophenone-3 (10%)	5	6
Ethylhexyl methoxycinnamate (10%)	2	0
Butyl methoxydibenzoylmethane (10%)	1	0
Benzophenone-10 (10%)	1	0
Benzophenone-4 (2%)	0	1
Ethylhexyl salicylate (5%)	0	1
Isoamyl- <i>p</i> -methoxycinnamate (10%)	1	0
Tinosorb® M (10%)	1	0
3,4',5-Tribromosalicylanilide (10%)	1	0
Total	12	8

photopatch test reactions to one or more photoallergens, giving a total of 20 photoallergic contact dermatitis reactions. Nineteen (95%) of the photoallergic contact reactions were caused by UV filters, with benzophenone-3 being responsible for 11 (55%) reactions (Table 2).

Of the 15 patients with positive photopatch test reactions, 11 (73%) sought treatment for suspected photoallergic contact dermatitis and 4 (26.7%) for sunscreen-induced skin reactions. Eight patients showed positive reactions on D6 that were not previously seen on D4 (Table 3). Regarding reaction relevance, the COADEX system classified eight reactions (40%) as current reactions, 11 (55%) as doubtful/unknown reactions, and one as being of old relevance (Table 2).

Allergic contact dermatitis reactions

Thirty-two patients (18 women and 14 men; mean age 47 years) showed positive reactions to one or more of the antigens on irradiated and non-irradiated skin (allergic contact reactions). There were a total of 47 allergic

contact dermatitis reactions. Of the allergens responsible for these reactions, the most frequent was fragrance mix I (31.91%), followed by, methylene bis-benzotriazolyl tetramethylbutylphenol (Tinosorb® M) (14.9%; Table 4). However, when UV filters were considered as a group, those affected constituted up to 53% of the total positive allergic contact reactions, seven (26.9%) of which were attributable to Tinosorb® M. Twenty-four reactions were classified as current reactions (51%), 20 as doubtful/unknown reactions (32.5%), and three as old reactions (6.4%; Table 4).

There were five photoinhibition reactions in 4 (4%) patients, and four photoexacerbation reactions in 3 (3%) patients. Five irritant reactions were found in 4 (4%) patients, to the following allergens: ethylhexyl methoxycinnamate, ethylhexyl salicylate, 3,4',5-tribromosalicylanilide, and musk ambrette.

Discussion

Photopatch testing is a valuable diagnostic tool for identifying the causal agents of photoallergic contact dermatitis and to search for allergens that can simulate this dermatosis (1, 5). This study found that the majority of patients seeking treatment for photoallergic contact dermatitis were women, as has been previously reported (13, 15–17). This effect can be explained by the greater tendency for women to consult specialists for skin problems, and the fact that women are more likely to use sunscreens and cosmetics that contain UV filters (1, 18, 17). There was no significant difference between the proportions of men and women who showed photoallergic contact reactions in the photopatch tests ($p > 0.05$); this contrasts with previous studies, which have reported a higher proportion for men (17, 19). There was agreement with previous reports regarding the mean age of patients who present with suspected photoallergic contact dermatitis (12, 18, 20, 21).

More than 30% of the positive allergic contact reactions appeared between D2 and D4 after allergen application during patch testing. In the cases with photoallergic contact reactions, allergen formation occurs after exposure to UV radiation, which justifies the extension of photopatch test readings through D6 (96 hr after irradiation) to avoid missing delayed reactions (10). A study in the United Kingdom identified 32 photoallergic contact reactions, but, when readings were extended to D5 and D6, 22 additional positive reactions were found that had not been evident at D4 (18). Pollock et al. found that late readings up to D7 did not confer any advantage (22). Our study showed that 53.3% of the positive photoallergic contact reactions occurred on D6. These results

highlight the importance of more extended readings in photopatch testing.

Whether allergens should be occluded for 24 or 48 hr for photopatch testing is controversial. Generally, photobiology clinics occlude for 24 hr, and contact dermatitis clinics for 48 hr. One investigation suggested that 48 hr of occlusion may increase the sensitivity of the test (10). In the multicentre European study (17), 13.8% of the subjects with 24 hr of occlusion had positive photoallergic contact reactions, whereas 30.2% of the patients with 48 hr of occlusion had positive photoallergic contact reactions. However, this study was not designed to investigate this issue, and the two study groups were not comparable. Thus, it will be necessary to further investigate this issue.

The frequency of patients with positive photopatch test reactions between the different publications has been highly variable, with positive frequencies as low as 2.3% (23) and as high as 45.5% (21). This range can be explained by the differences in the populations studied, the patient selection process, and the allergens used (12, 13, 18). UV filters caused the highest frequency of photoallergic contact dermatitis reactions in this study (95%). This finding agrees with the majority of the published literature (12, 15, 18, 19, 21, 24, 25). In several European countries, the most common causes of these reactions are the NSAIDs, particularly ketoprofen (8, 13, 17, 26), and the UV filter octocrylene (17, 16). This finding was not corroborated in our photopatch study; only 2 patients had a non-relevant positive allergic contact reaction to ketoprofen, and no patients reacted to octocrylene. None of the patients included in the study recalled having used topical NSAIDs. Although these medicaments are available in Colombia, perhaps they are not used frequently in our population; we did not find any study regarding the use of topical NSAIDs in our country.

Of the UV filters, benzophenone-3 caused the largest proportion of photoallergic contact dermatitis reactions in our study, as has also been reported worldwide (7, 19, 20, 23–25). Benzophenone-3 was followed by ethylhexyl methoxycinnamate, which had lower reported percentages of positive reactions (between 3% and 4%) in other studies (18, 27–29).

The previous 2001–2003 study conducted at our institution found a higher frequency of patients showing positive photopatch test reactions (31.7%) than the present study (15%). This difference is probably a result of the fact that benzophenone-3, which is responsible for the majority of these reactions, has been removed from many of the sunscreens in Colombia, which are the main sources of this product.

In this study, only 1 patient showed a photoallergic contact reaction to 3,4',5-tribromosalicylanilide, a

Table 4. Allergens responsible for allergic contact dermatitis reactions and their relevance

Allergen in petrolatum	Frequency	%	C	D	O
Fragrance mix I (8%)	15	31.9	5	9	1
Tinosorb® M (10%)	7	14.9	6	1	0
Benzophenone-3 (10%)	4	8.5	3	1	0
Ethylhexyl methoxycinnamate (10%)	4	8.5	2	2	0
Ethylhexyl dimethyl PABA (10%)	3	6.4	3	0	0
4-Methylbenzylidene camphor (10%)	2	4.3	2	0	0
Benzophenone-10 (10%)	2	4.3	0	2	0
Ethylhexyl salicylate (5%)	2	4.3	1	1	0
Ketoprofen (1%)	2	4.3	0	2	0
Musk ambrette (5%)	2	4.3	1	1	0
Butyl methoxydibenzoylmethane (10%)	1	2.1	1	0	0
Isoamyl- <i>p</i> -methoxycinnamate (10%)	1	2.1	0	0	1
Sesquiterpene lactone mix (0.1%)	1	2.1	0	0	1
Triclosan (2%)	1	2.1	0	1	0
Total	47	100	24	20	3

C, current; D, doubtful/unknown; O, old.

halogenated salicylanilide that is an antibacterial product used in soaps; it was the source of many cases of photoallergic contact dermatitis in the past, and was removed from the market in Europe (14). It may still be present in products available in Colombia; thus, we suggest including it in the set of allergens for photopatch testing in our country.

There were no photoallergic contact reactions to the sesquiterpene lactone mix, fragrance mix I, triclosan, ketoprofen, or musk ambrette. However, some of these substances generated allergic contact dermatitis reactions, especially fragrance mix I. Reactions to fragrance mix I could clinically present as photoallergic contact dermatitis, but they are actually allergic contact reactions (airborne contact dermatitis) (30). The frequency of positive contact allergic reactions in photopatch tests has varied greatly between publications (12, 17, 19). Fragrances and UV filters are the main allergens responsible for these reactions (12, 13, 18, 19), as was also observed in this study. In other recent publications, Tinosorb® M was the principal causative agent of contact allergic reactions in photopatch test studies (17, 31). This finding was corroborated in our study, which found 14.8% contact allergic reactions to Tinosorb® M. This is probably because this UV filter is a component in many commercial sunscreens available in Colombia. Decyl glucoside is a non-ionic surfactant present in Tinosorb® M, as a stabilizer, and is responsible for the contact allergic reactions caused by this UV filter (31–34). Some authors recommend patch testing decyl glucoside in parallel with the photopatch test series (14). However, it was not included in the present study, because it was not yet known to be a recommended parallel test substance when our study was designed.

We identified two doubtful/unknown allergic contact reactions to ketoprofen, although this allergen is a common cause of photoallergic contact dermatitis, especially in Europe (8, 13, 17); it is also responsible for some cases of allergic contact dermatitis (35–37). Several patients with contact allergy or photocontact allergy to ketoprofen had also allergic contact reactions to other allergens, including fragrance mix I, particularly to one of its components, cinnamyl alcohol (26, 35, 36). There is cross-sensitization between ketoprofen and cinnamyl alcohol, probably because of their common molecular characteristics (36, 38). One of our patients with an allergic contact reaction to ketoprofen also showed an allergic contact reaction to fragrance mix I, but he was not patch tested with cinnamyl alcohol to confirm this cross-reaction.

A search of the current literature showed no reports of photopatch test studies in Latin American countries. In Colombia, these tests have been exclusively performed by our centre, the Centro Dermatológico Federico Lleras Acosta.

Determining the relevance of photopatch test readings is not straightforward. Although systems such as COADDEX have been designed, patients often do not remember what products they applied or cannot have them on hand at the clinic to verify the chemical compositions. In this study, the relevance of the positive photopatch test reactions was doubtful/unknown in 55% of the cases. Several patients who had reactions to UV filters insisted that they had not used sunscreens. It is important to remember that some UV filters, such as benzophenone-3, are also found in cosmetics and hygiene products, and that the excipients in sunscreens, such as

fragrances, formaldehyde releasers, preservatives, and lanolin alcohol, can cause allergic contact dermatitis (39–41). In the previously mentioned multicentre European study, 44.3% of the photopatch test reactions were classified as current and 32% as doubtful/unknown, with the same COADEX system being used to determine relevance (17). In our study, 40% were current reactions and 55% were doubtful/unknown reactions. Few other studies have assessed this aspect, and evaluation systems vary (12, 27), thus preventing the comparison of results between studies.

In conclusion, UV filters, particularly benzophenone-3, remain the most frequent causes of photoallergic contact dermatitis in our patients. According to these results, photopatch test series in our population should include halogenated salicylanilides and UV filters. Parallel patch tests with specific antigens allow additional interpretation. Many UV filters, such as Tinosorb® M which is present in most new sunscreens, may also cause allergic

contact dermatitis, owing to the emulsifying agent, decyl glucoside. Therefore, it is important to perform a parallel patch test with decyl glucoside. It is also useful to perform a parallel patch test with fragrance mix I to differentiate airborne contact dermatitis from photoallergic contact dermatitis. As shown by the number of delayed reactions found in this study, this highlights the importance of taking readings until D6.

More studies are needed to identify other allergens responsible for photoallergic contact dermatitis in our population, given the low frequency of positive reactions among the allergens tested.

Acknowledgements

We thank Dr Guillermo Sánchez, epidemiologist and public health physician, for his help with the methodological design and statistical analysis.

References

- Goossens A. Photoallergic contact dermatitis. *Photodermatol Photoimmunol Photomed* 2004; **20**: 121–125.
- Kerr A, Ferguson J. Photoallergic contact dermatitis. *Photodermatol Photoimmunol Photomed* 2010; **26**: 56–65.
- Photopatch testing – methods and indications. British Photodermatology Group. *Br J Dermatol* 1997; **136**: 371–376.
- Deleo V A. Photocontact dermatitis. *Dermatol Ther* 2004; **17**: 279–288.
- Isaksson M, Bruze M. Photopatch testing. *Clin Dermatol* 1997; **15**: 615–618.
- Jansén C T, Wennersten G, Rystedt I, Thune P, Brodthagen H. The Scandinavian standard photopatch test procedure. *Contact Dermatitis* 1982; **8**: 155–158.
- Hölzle E, Neumann N, Hausen B, Przybilla B, Schauder S, Hönigsmann H, Bircher A, Plewig G. Photopatch testing: the 5-year experience of the German, Austrian, and Swiss Photopatch Test Group. *J Am Acad Dermatol* 1991; **25**: 59–68.
- de la Cuadra-Oyanguren J, Pérez-Ferriols A, Lecha-Carretero M, Giménez-Arnau A M, Fernández-Redondo V, Ortiz de Frutos F J, Silvestre-Salvador J F, Serra-Baldrich E. Results and assessment of photopatch testing in Spain: towards a new standard set of photoallergens. *Actas Dermosifiliogr* 2007; **98**: 96–101.
- Bruynzeel D P, Ferguson J, Andersen K et al. Photopatch testing: a consensus methodology for Europe. *J Eur Acad Dermatol Venereol* 2004; **18**: 679–682.
- Batchelor R J, Wilkinson S M. Photopatch testing – a retrospective review using the 1 day and 2 day irradiation protocols. *Contact Dermatitis* 2006; **54**: 75–78.
- Bourke J, Coulson I, English J. Guidelines for care of contact dermatitis. *Br J Dermatol* 2001; **145**: 877–885.
- Victor F C, Cohen D E, Soter N A. A 20-year analysis of previous and emerging allergens that elicit photoallergic contact dermatitis. *J Am Acad Dermatol* 2010; **62**: 605–610.
- Pigatto P D, Guzzi G, Schena D et al. Photopatch tests: an Italian multicentre study from 2004 to 2006. *Contact Dermatitis* 2008; **59**: 103–108.
- Gonçalo M, Ferguson J, Boneville A et al. Photopatch testing: recommendations for a European photopatch test baseline series. *Contact Dermatitis* 2013; **68**: 239–243.
- Rodríguez E, Valbuena M C, Rey M, Porras de Quintana L. Causal agents of photoallergic contact dermatitis diagnosed in the national institute of dermatology of Colombia. *Photodermatol Photoimmunol Photomed* 2006; **22**: 189–192.
- Scalf L A, Davis M D, Rohlinger A L, Connolly S M. Photopatch testing of 182 patients: a 6-year experience at the Mayo Clinic. *Dermatitis* 2009; **20**: 44–52.
- European Multicentre Photopatch Test Study (EMCPTS) Taskforce. A European multicentre photopatch test study. *Br J Dermatol* 2012; **166**: 1002–1009.
- Bryden A M, Moseley H, Ibbotson S H et al. Photopatch testing of 1155 patients: results of the UK multicentre photopatch study group. *Br J Dermatol* 2006; **155**: 737–747.
- Greenspoon J, Ahluwalia R, Juma N, Rosen C F. Allergic and photoallergic contact dermatitis: a 10-year experience. *Dermatitis* 2013; **24**: 29–32.
- Neumann N J, Hölzle E, Plewig G, Schwarz T, Panizzon R G, Breit R, Ruzicka T, Lehmann P. Photopatch testing: the 12-year experience of the German, Austrian, and Swiss photopatch test group. *J Am Acad Dermatol* 2000; **42**: 183–192.
- Chuah S Y, Leow Y H, Goon A T, Theng C T, Chong W S. Photopatch testing in Asians: a 5-year experience in Singapore. *Photodermatol Photoimmunol Photomed* 2013; **29**: 116–120.
- Pollock B, Wilkinson S M. Photopatch test method: influence of type of irradiation and value of day-7 reading. *Contact Dermatitis* 2001; **44**: 270–272.
- Darvay A, White I R, Rycroft R J, Jones A B, Hawk J L, McFadden J P. Photoallergic contact dermatitis is uncommon. *Br J Dermatol* 2001; **145**: 597–601.
- Cardoso J C, Canelas M M, Gonçalo M, Figueiredo A. Photopatch testing with an extended series of photoallergens: a 5-year study. *Contact Dermatitis* 2009; **60**: 325–329.

- 25 Bakkum R S, Heule F. Results of photopatch testing in Rotterdam during a 10-year period. *Br J Dermatol* 2002; **146**: 275–279.
- 26 Hindsén M, Zimerson E, Bruze M. Photoallergic contact dermatitis from ketoprofen in southern Sweden. *Contact Dermatitis* 2006; **54**: 150–157.
- 27 Jindal N, Sharma N L, Mahajan V K, Shanker V, Tegta G R, Verma G K. Evaluation of photopatch test allergens for Indian patients of photodermatitis: preliminary results. *Indian J Dermatol Venereol Leprol* 2011; **77**: 148–155.
- 28 Berne B, Ros A M. 7 years experience of photopatch testing with sunscreen allergens in Sweden. *Contact Dermatitis* 1998; **38**: 61–64.
- 29 Schauder S, Ippen H. Contact and photocontact sensitivity to sunscreens. Review of a 15-year experience and of the literature. *Contact Dermatitis* 1997; **37**: 221–232.
- 30 Santos R, Goossens A. An update on airborne contact dermatitis: 2001–2006. *Contact Dermatitis* 2007; **57**: 353–360.
- 31 Gonzalez M E, Soter N A, Cohen D E. Positive patch- and photopatch-test reactions to methylene bis-benzotriazolyl tetramethylbutylphenol in patients with both atopic dermatitis and chronic actinic dermatitis. *Dermatitis* 2011; **22**: 106–111.
- 32 Pereira N, Coutinho I, Andrade P, Gonçalo M. The UV filter tinosorb M, containing decyl glucoside, is a frequent cause of allergic contact dermatitis. *Dermatitis* 2013; **24**: 41–43.
- 33 Andrade P, Gonçalo M, Figueiredo A. Allergic contact dermatitis to decyl glucoside in Tinosorb M. *Contact Dermatitis* 2010; **62**: 119–120.
- 34 Andersen K E, Goossens A. Decyl glucoside contact allergy from a sunscreen product. *Contact Dermatitis* 2006; **54**: 349–350.
- 35 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**: 159–166.
- 36 Foti C, Bonamonte D, Conserva A, Stingeni L, Lisi P, Lionetti N, Rigano L, Angelini G. Allergic and photoallergic contact dermatitis from ketoprofen: evaluation of cross-reactivities by a combination of photopatch testing and computerized conformational analysis. *Curr Pharm Des* 2008; **14**: 2833–2839.
- 37 Mathieu L, Meuleman L, Van Hecke E, Blondell A, Dezfoulian B, Constandt L, Goossens A. Contact and photocontact allergy to ketoprofen. The Belgian experience. *Contact Dermatitis* 2004; **50**: 238–241.
- 38 Girardin P, Vigan M, Humbert P, Aubin F. Cross-reactions in patch testing with ketoprofen, fragrance mix and cinnamic derivatives. *Contact Dermatitis* 2006; **55**: 126–128.
- 39 Warshaw E M, Wang M Z, Maibach H I et al. Patch test reactions associated with sunscreen products and the importance of testing to an expanded series: retrospective analysis of North American Contact Dermatitis Group data, 2001 to 2010. *Dermatitis* 2013; **24**: 176–182.
- 40 Scheuer E, Warshaw E. Sunscreen allergy: a review of epidemiology, clinical characteristics, and responsible allergens. *Dermatitis* 2006; **17**: 3–11.
- 41 Sasseville D, Nantel-Battista M, Molinari R. Multiple contact allergies to benzophenones. *Contact Dermatitis* 2011; **65**: 179–181.