Photopatch and UV-irradiated patch testing in photosensitive dermatitis

Reena Rai, Maria Thomas

Department of Dermatology, PSG Hospitals, Coimbatore, Tamil Nadu, India

ABSTRACT

Background: The photopatch test is used to detect photoallergic reactions to various antigens such as sunscreens and drugs. Photosensitive dermatitis can be caused due to antigens like parthenium, fragrances, rubbers and metals. The photopatch test does not contain these antigens. Therefore, the Indian Standard Series (ISS) along with the Standard photopatch series from Chemotechnique Diagnostics, Sweden was used to detect light induced antigens. **Aim:** To detect light induced antigens in patients with photosensitive dermatitis. **Methods:** This study was done in a descriptive, observer blinded manner. Photopatch test and ISS were applied in duplicate on the patient's back by the standard method. After 24 hours, readings were recorded according to ICDRG criteria. One side was closed and other side irradiated with 14 J/cm^2 of UVA and a second set of readings were recorded after 48 hrs. **Result:** The highest positivity was obtained with parthenium, with 18 out of 35 (51%) patients showing a positive patch test reaction with both photoallergic contact dermatitis and photoaggravation. Four patients (11%) showed positive patch test reaction suggestive of contact dermatitis to potassium dichromate and fragrance mix. Six patients had contact dermatitis to numerous antigens such as nickel, cobalt, chinoform and para-phenylenediamine**.** None of these patients showed photoaggravation on patch testing. **Conclusion:** Parthenium was found to cause photoallergy, contact dermatitis with photoaggravation and contact allergy. Hence, photopatch test and UV irradiated patch test can be an important tool to detect light induced antigens in patients with photosensitive dermatitis.

Key words: Photopatch, parthenium, photoallergy

Access this article online

Website: www.idoj.in

DOI: 10.4103/2229-5178.174319

Quick Response Code:

Address for correspondence:
Dr. Maria Thomas, Department of Dermatology, PSG Hospitals, Coimbatore - 641 004, Tamil Nadu, India.
E-mail: drreena_rai@yahoo.co.in

INTRODUCTION

Sunlight is the basic component of a variety of biochemical reactions necessary to sustain life in its many forms. The interaction of ultraviolet or visible light of a specific wavelength with certain molecules or photosensitizing chemicals leads to a delayed type hypersensitivity reaction that causes photocontact dermatitis.[1]

The primary investigation for the detection of photodermatitis is the photopatch test, which helps in the investigation and detection of specific allergens that cause photodermatitis in a susceptible individual. It involves exposure of the skin to appropriate amounts of an allergen implicated in causing photoallergic contact dermatitis and recording the subsequent response with and without light exposure.[2]

The primary indication for the test would be dermatitis predominantly limited to sun exposed sites of uncertain aetiology.[3]

The antigens used in the photopatch series include sunscreens, nonsteroidal anti-inflammatory drugs (NSAIDs), and fragrances; specific antigens are added based of information provided by the patient. Although various differences exist in the procedure, irradiation doses, interpretation, and antigens of photopatch test, only 4%–20% of patients undergoing photopatch tests show clinically positive relevant results.[4]

Common photosensitizing agents include chemicals present in sunscreens, antiseptic

Cite this article as: Rai R, Thomas M. Photopatch and UV-irradiated patch testing in photosensitive dermatitis. Indian Dermatol Online J 2016;7:12-6.

agents, fragrances, and nonsteroidal anti-inflammatory drugs. In India, *Parthenium hysterophorus* is probably the most common cause of photoallergic contact dermatitis and airborne contact dermatitis.[5]

The diagnosis of a photodermatitis is based on the history and clinical examination and is confirmed by photopatch testing. It is important to rule out other causes of photoexposed site reactions such as connective tissue disease, drugs, allergic contact dermatitis, and pophyrias while investigating a patient of suspected photoallergy.

There is no Indian standard photopatch test series available, and studies carried out in India have used European or Scandinavian photopatch test trays, which may not be relevant for Indian patients.

Hence we have used a combination of photopatch test and UV-irradiated Indian Standard Series (ISS) in our study, to detect light-induced antigens in patients with photosensitive dermatitis.

MATERIALS AND METHODS

This study was done as a hospital-based, descriptive, observer blinded study. A total of 35 patients were included in the study during a one year period between September 2012 and October 2013. Clearance from the ethical committee was obtained and written informed consent was taken from all patients involved in the study. Patch and photopatch testing was performed on all the patients using the ISS and Photopatch Series. Both were obtained from Chemotechnique Diagnostics, Sweden.

The antigens included in the ISS were: 1- Control, 2- Potassium Dichromate, 3- Neomycin sulfate, 4- Cobalt chloride, 5- Benzocaine, 6- Formaldehyde, 7- Paraphenylenediamine (PPD), 8- Parabens, 9- Nickel sulfate, 10- Colophony, 11- Gentamicin, 12- Mercapto mix, 13- Epoxy resin, 14- Fragrance mix, 15- Mercaptobenzothiazole, 16- Nitrofurazone, 17- Polyehyleneglycol-400, 18- Chlorocresol, 19- Wool alcohols, 20- Balsam Peru, 21- Thiruram mix, 22- Chinoform, 23- Black rubber Mix, and 24- P-TBP F Resin.

The Photopatch series consisted of: 1- Benzophenone-3, 2- Benzophenone-4, 3- Eusolex 232, 4- ButylmethoxyDibenzoyl methane (Parsol 1789), 5- Para amino benzoic acid, 6- 3(4 Methyl benzyliden) camphor, 7- Octyltriazone, 8- Octyl methoxycinnamate, 9- Ibuprofen 5%, 10- Piroxicam 5%, 11- Ketoprofen 2.5%, 12- Isomyl 4-methoxycinnamate 10%, 13- Fragrance mix 8%, and 14- Parthenium.

The patients included in the study presented with dermatitis predominantly affecting sun exposed areas or with a history of photosensitivity. Clinically suspected cases of phototoxic or photoallergic contact dermatitis secondary to drugs, chemicals, or airborne antigens were also included in the study.

Patients on systemic immunosuppressants, oral steroids, exfoliative and active dermatitis, pregnant or lactating women, and those below 18 years of age were excluded from the study. Those with photosensitivity due to conditions such as connective tissue disease and genetic disorders with photosensitivity were also excluded.

A detailed history was taken with regard to onset, duration and progression of disease, type and distribution of lesions, and presence of any comorbid conditions. All patients that fit the criteria for inclusion were subjected to a thorough clinical examination. Photographs of each patient were taken using a DSLR Nikon D500 camera. Photographs of the patch test sites were taken at each reading to document positive reactions.

Both sets of patches were applied in duplicate on the patient's back, on either side of the spine by the standard method. The antigens were loaded onto Finn chambers and secured with Scanpor tape. Plain petrolatum was used as the vehicle. The patients were advised to keep the area dry and avoid wetting the back. After 24 h, the tapes were carefully removed and squares representing each chamber were marked using a marker pen. Readings were recorded after a gap of half an hour, into the respective proformas.

After noting relevant readings, one side was closed with an opaque black cloth and the other side was irradiated with 14 J/cmsq of UVA. The selection of side to be irradiated was done in a randomized, observer-blinded manner. The UVA source was a standard phototherapy unit with Philips TL/10R tubes.

A distance of 15 cm was kept between the patient's back and irradiation source. Readings were then recorded after 48 h. At the end of the protocol, two sets of readings were obtained considering the day of patch application as day 0. First reading was at 24 h after application of patches, followed by UVA irradiation (day 1). Second reading was at 48 h post irradiation (day 3).

The patch test results were evaluated using the International Contact Dermatitis Research Group (ICDRG) grading. Photopatch test was interpreted according to the standard photopatch criteria.[6] According to the criteria, if only the irradiated side shows a positive reaction, it is labeled as a photoallergic reaction. If both sides show a positive reaction with the irradiated side showing greater than 1+ positivity, it is termed as a contact dermatitis with photoaggravation. If both sides show equal reaction after irradiation, a contact allergy is the result.

RESULTS

Out of the 35 patients included in the study, 10 (29%) were females and 25 (71%) were males and all patients were outdoor

workers. Majority (66%) of patients belonged to the age group ranging from 35 to 65 years. A total of 24 (69%) patients had positive patch or photopatch test results. Eleven patients were negative to both tests.

Majority of these patients 21 (60%) had features of chronic dermatitis confined mainly to the sun-exposed areas with a history of photosensitivity. The remaining 14 (40%) patients presented with a history of photosensitivity with dermatititis present both in sun-exposed and covered areas. Twelve patients among the total study population had a positive history of atopy with IgE levels above 1000 IU/mL.

Out of 35 patients, 11 were negative to both ISS and photopatch tests. The highest number of photopatch reactions was noted with parthenium, with 18 (51%) patients showing positive results. The detailed results of the 18 patients with a positive photopatch test suggestive of photodermatitis are shown in Table 1. Out of the 18 patients, 9 (50%) showed contact allergy, 4 (22%) had photoallergy, and 5 (28%) had contact dermatitis with photoaggravation to *P. hysterophorus*. Five patients among the 18 patients had coexistent contact dermatitis to other antigens in the ISS.

Six patients had contact dermatitis without any photoaggravation or photoallergy to varied antigens such as potassium dichromate, chinoform, fragrance, para-phenylenediamine, nickel, and cobalt.

DISCUSSION

In our study, *P. hysterophorus* was the leading allergen with 51% of the study population showing a positive reaction. This

Table 1: Detailed results of the 18 patients who showed positive photopatch test results

Patient no	Patch test (ISS)				Photopatch test				Interpretation
	Day 1 (24 h)		Day 3 (48 h post-IR)		Day 1 (24 h)		Day 3 (48 h post-IR)		
	Left	Right	nIR	IR	Left	Right	nIR	IR	
1	−ve	−ve	−ve	−ve	2+	2+	2+	2+	Contact allergy to parthenium
2	−ve	−ve	−ve	1+ to balsam of Peru	1+	1+	2+	2+	Photoallergy to balsam of Peru, contact allergy to parthenium
3	−ve	−ve	−ve	−ve	1+	1+	2+	2+	Contact allergy to parthenium
4	−ve	−ve	−ve	−ve	2+	2+	3+	3+	Contact allergy to parthenium
5	−ve	−ve	−ve	−ve	1+	1+	1+	1+	Contact allergy to parthenium
6	−ve	−ve	−ve	−ve	−ve	−ve	1+	1+	Contact allergy to parthenium
7	−ve	−ve	−ve	−ve	−ve	−ve	3+	3+	Contact allergy to parthenium
8	−ve	−ve	−ve	−ve	1+	1+	1+	1+	Contact allergy to parthenium
9	1+ to nickel 1+ to cobalt 1+ to fragrance	1+ to nickel 1+ to cobalt 1+ to fragrance	1+ to nickel 1+ to cobalt 1+ to fragrance	1+ to nickel 1+ to cobalt 1+ to fragrance	−ve	−ve	−ve	1+	Photoallergy to parthenium contact dermatitis to nickel/ cobalt/fragrance
10	1+ to fragrance	1+ to fragrance	1+ to fragrance	1+ to fragrance	1+ to fragrance 2+	1+ to fragrance 2+	1+ to fragrance 2+	1+ to fragrance 2+	Contact allergy to fragrance mix and parthenium
11	1+ to nickel 1+ to cobalt 1+ to chinoform	1+ to nickel 1+ to cobalt 1+ to chinoform	1+ to nickel 1+ to cobalt 2+ to chinoform	1+ to nickel 1+ to cobalt 2+ to chinoform	1+	1+	1+	2+	Photoaggravation to parthenium contact dermatitis to nickel/ cobalt/chinoform
12	−ve	−ve	−ve	−ve	1+	1+	1+	2+	Photoaggravation to parthenium
13	−ve	−ve	−ve	−ve	1+	!+	!+	2+	Photoaggravation to parthenium
14	2+ to potassium dichromate 1+ to parabens and colophony	2+ to potassium dichromate 1+ to parabens and colophony	1+ to potassium dichromate 1+ to parabens and colophony	1+ to potassium dichromate 1+ to parabens and colophony	1+	1+	1+	2+	Contact dermatitis to dichromate, parabens and colophony Photoaggravation to parthenium
15	−ve	−ve	−ve	−ve	−ve	−ve	1+	2+	Photoaggravation to parthenium
16	−ve	−ve	−ve	−ve	−ve	−ve	−ve	1+	Photoallergy to parthenium
17	−ve	−ve	−ve	−ve	−ve	−ve	−ve	1+	Photoallergy to parthenium
18	−ve	−ve	−ve	−ve	−ve	−ve	−ve	1+	Photoallergy to parthenium

IR: Irradiated side, nIR: Nonirradiated side, Photopatch test is positive to parthenium unless otherwise indicated in the columns

is expected due to the widespread presence of parthenium in the locality and surrounding areas.

In a similar study carried out by Jindal *et al*., 30 patients were subjected to photopatch testing along with some antigens obtained from the standard series. Fourteen positive tests to several allergens were obtained with fragrance mix being the leading antigen (30%), followed by para-phenylenediamine (20%) and *P. hysterophorus* (17%).[4]

Sharma and Kaur found 78% of patients with airborne contact dermatitis to have parthenium sensitivity.[7] In another study done by Sharma *et al*., 19 patients were subjected to photopatch test to parthenium. Three patients showed photoallergic reaction and another 3 showed photoaggravation out of 19 patients.[8] In our study 4 patients showed photoallergy and 5 patients showed contact dermatitis with photoaggravation.

Numerous studies have established the role of parthenium in causing photocontact dermatitis. This is possibly due to its abundant and widespread growth and high sensitizing potential.[9] The major antigens in *P. hysterophorus* are sesquiterpene lactones. Some of the identified lactones are parthenin, hymenin, ambrosin, and coronopilin. Parthenium is established to cause both photoallergy and contact dermatitis with photoaggravation.[10,11]

In a study done by Kar *et al*., it was observed that parthenium plays a significant role in the initiation and spread of air borne contact dermatitis and chronic actinic dermatitis (CAD).[12] A 20-year analysis of antigens causing photoallergic contact dermatitis done in New York showed 11.6% positivity to plant derivatives including sesquiterpene lactone mix.[13] The coexistence of allergic contact dermatitis (ACD) with CAD is well known. In most of these cases features of ACD appear well in advance before the onset of photosensitivity.[14]

About 75% of patients with CAD show a positive patch test response to one or more allergens. Among the various plant antigens, sesquiterpene lactones obtained from plants of the Compositae family are the most common causative antigens apart from fragrance, rubber, metals, colophony, chromates, and sunscreens.[15-17]

The second most common allergens in our study were fragrance mix and potassium dichromate. In our study, 4 out of the 35 patients exhibited contact allergy to fragrance. Photoallergy due to fragrance can be due to the perfume compound itself of the fixative agent such as musk ambrette. In a study done by Panja *et al*., fragrance mix was the leading photosensitizer.[6]

Metals such as nickel, cobalt, and dichromates are common sensitizing agents. Three patients (30%) showed positive patch test reactions, to nickel and cobalt in our study. These sensitizers are found in jewelry, watches, cement, leather, and dyes. Chronic exposure to these allergens in the presence of ultraviolet radiation facilitates increased immune recognition and aggravation of pre-existing dermatitis.

Various differences exist in the pattern of antigen positivity depending on the area and population under study. The positivities obtained in Western literature are to certain antigens not so frequently encountered in the Indian scenario. In a recent study from the United States, sunscreens and anti-microbial agents were the predominant antigens and a decreased incidence in fragrance induced photoallergic contact dermatitis was found.[18]

The most common positive antigens in photopatch tests in western studies were sunscreens and drugs such as NSAIDs.[19] The increased prevalence is indicative of widespread sunscreen use in these countries. Photoallergy due to sunscreens are predominantly caused due to organic UV filters. No positivity to sunscreens was detected in our study, probably due to infrequent use in the given population.

NSAIDs have been increasingly used especially in topical forms to alleviate musculoskeletal pain. None of the cases in our study exhibited sensitivity to NSAIDs.

The leading allergens in the Scandinavian multicentric photopatch study were musk ambrette and para amino benzoic acid.[19] We did not encounter any positivity to these antigens in our study.

One patient showed positive reaction to PPD. In a study done by Jindal *et al*. 6 out of 20 patients showed contact allergy to PPD with two patients having photoaggravation.[4] Although PPD is known to cause photoallergic reactions, our patient did not exhibit the same.

In our study, six patients had contact dermatitis to various antigens such as nickel, cobalt dichromates, and PPD. Although these sensitizers have been implicated in photoaggravated contact dermatitis, none of our patients showed such a response pattern.

CONCLUSION

Photodermatitis is prevalent in India, and prompt identification of the causative antigens will alleviate the morbidity associated with this condition. Photoallergic contact dermatitis is largely underdiagnosed in our country due to lack of availability of proper photopatch protocols. Parthenium was found to be the leading cause of photodermatitis in our study causing photoallergy, contact dermatitis with photoaggravation, and contact allergy. Among the 18 parthenium-positive patients, five

had coexistent contact dermatitis to other antigens in the ISS. In this context, patch testing with both ISS and photopatch series could lead to clinically relevant results. Patch testing is a simple diagnostic tool to detect contact allergens. It is advantageous as it is noninvasive, simple to carry out, and can be performed on an outpatient basis. Thus, patch testing with combined ISS and photopatch series can be efficacious in the detection of antigens causing photosensitive dermatitis.

Limitations

1. A 24- and 48-h photopatch test reading was taken. Our inability to take delayed readings at 72/96 h or even one week may have resulted in false-negative results.
2. Minimal Erythema Dose or MED is the least amount of UV radiation required to produce perceptible erythema on light exposed skin. This factor was not was not determined in our study.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

REFERENCES

1. Saint-Mezard P, Rosieres A, Krasteva M, Berard F, Dubois B, Kaiserlian D, *et al*. Allergic contact dermatitis. Eur J Dermatol 2004;14:284-95.
2. Kerr A, Ferguson J. Photoallergic contact dermatitis. Photodermatol Photoimmunol Photomed 2010;26:56-65.
3. Bruynzeel D, Ferguson J, Andersen K, Gonçalo M, English J, Goossens A, *et al*.; European Taskforce for Photopatch Testing. Photopatch testing: A consensus methodology for Europe. J Eur Acad Dermatol Venereol 2004;18:679-82.
4. Jindal N, Sharma NL, Mahajan VK, Shanker V, Tegta GR, Verma GK. Evaluation of photopatch test allergens for Indian patients of photodermatitis: Preliminary results. Indian J Dermatol Venereol Leprol 2011;77:148-55.
5. Kanchan PA, Shenoi SD, Balachandran C. Five years experience of photopatch testing in 50 patients. Indian J Dermatol Venereol Leprol 2002;68:86-7.
6. Panja A, Srinivas CR, Shenoy SD, Balachandran C. Patch photopatch test at Manipal. Indian J Dermatol Venereol Leprol 1994;60:337-9.
7. Sharma SC, Kaur S. Airborne contact dermatitis from Compositae plants in northern India. Contact Dermatitis 2006;21:1-5.
8. Sharma VK, Sethuraman G, Bhat R. Evolution of clinical pattern of parthenium dermatitis: A study of 74 cases. Contact Dermatitis 2005;53:84-8.
9. Bhutani LK, Rao DS. Photocontact dermatitis caused by *Parthenium hysterophorous*. Dermatologica 1978;157:206-9.
10. Sharma VK, Sethuraman G, Bansal A. Evaluation of photopatch test series in India. Contact Dermatitis 2007;56:168-9.
11. Jeanmougin M, Taïeb M, Manciet JR, Moulin JP, Civatte J. Photo-aggravated *Parthenium hysterophorus* contact eczema. Ann Dermatol Venereol 1988;115:1238-40.
12. Kar HK, Langar S, Arora TC, Sharma P, Raina A, Bhardwaj M. Occurrence of plant sensitivity among patients of photodermatoses: A control-matched study of 156 cases from New Delhi. Indian J Dermatol Venereol Leprol 2009;75:483-7.
13. Scalf LA, Davis MD, Rohlinger AL, Connolly SM. Photopatch testing of 182 patients: A 6-year experience at the Mayo Clinic. Dermatitis 2009;20:44-52.
14. Norris PG, Hawk JL. Chronic actinic dermatitis. A unifying concept. Arch Dermatol 1990;126:376-8.
15. Frain-Bell W, Hetherington A, Johnson BE. Contact allergic sensitivity to chrysanthemum and the photosensitivity dermatitis and actinic reticuloid syndrome. Br J Dermatol 1979;101:491-501.
16. Menage H, Ross JS, Norris PG, Hawk JL, White IR. Contact and photocontact sensitization in chronic actinic dermatitis: Sesquiterpene lactone mix is an important allergen. Br J Dermatol 1995;132:543-7.
17. Somani VK. Chronic actinic dermatitis: A study of clinical features. Indian J Dermatol Venereol Leprol 2005;71:409-13.
18. Victor FC, Cohen DE, Soter NA. A 20-year analysis of previous and emerging allergens that elicit photoallergic contact dermatitis. J Am Acad Dermatol 2010;62:605-10.
19. Thune P, Jansén C, Wennersten G, Rystedt I, Brodthagen H, McFadden N. The Scandinavian multicenter photopatch study 1980-1985: Final report. Photodermatol 1988;5:261-9.