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A Case of Type IV Solar Urticaria Identified by Reverse *in Vitro* Serum Test

Hirotake OZAKI, Takashi MATSUYAMA, Yo KAWAKUBO, Motomi MIYAHARA and Akira OZAWA

Department of Dermatology, Tokai University School of Medicine

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We had a 17-year-old male patient with solar urticaria diagnosed as type IV of modified Harber's classification. The action spectrum of this case was estimated to be 433-499 nm and the inhibition spectrum was 533 nm. Both *in vitro* serum test and tentatively designated "reverse *in vitro* serum test" were positive. The patient was prescribed 20 mg/day epinastine hydrochloride (Alesion®) orally for 49 weeks with improvement of the symptoms.

Key words : solar urticaria; visible light; reverse *in vitro* serum test

INTRODUCTION

Solar urticaria is characterized by localized wheal formation and itching immediately after sunlight exposure. It was reported for the first time in 1904 by Merkelin [1]. In Japan, Yamashita (2) documented the first case of solar urticaria in 1916 and, since then, more than 100 cases have been reported [3]. The inhibition spectrum has been described in 23 cases [4, 5]. The reported inhibition spectra distributed in the visible light range and were always longer than the action spectrum in every case. Recently, we had a case of solar urticaria and investigated the action and inhibition spectra and reverse *in vitro* serum test.

CASE DESCRIPTION

Case: A 17-year-old male.

Chief complaint: Rash on the face and both upper arms accompanied by itchy sensation.

First visit: October 4, 1999.

Family and past histories: Nothing particular.

Present history: Since June, 1999, the patient developed wheals on the exposed areas approximately 20 minutes after sun exposure. The symptoms faded within approximately 1 hour in the shade. He consulted a nearby practioner and the symptoms were diagnosed as urticaria. He was prescribed oxatomide (Celtect®) orally for 2 weeks, with no improvement of the symptoms. In October, 1999, he visited us and, with a presumed diagnosis of solar urticaria, we practiced thorought examinations.

Present illness: On examination, no remarkable eruption was observed.

Laboratory data: Regular laboratory examinations, such as complete blood count, liver function, urine analysis and stool porphyrin test, revealed no evidence for porphyria. Hemolysis test for porphyria was negative.

EXAMINATIONS FOR SOLAR URTICARIA

Light test

1) Light irradiation test: Using Dermaray (TOREX, Tokyo, Japan), irradiation with 10 J/cm^2 of UVA and 0.01-0.1 J/cm^2 of

Hirotake OZAKI, Department of Dermatology, Tokai University School of Medicine, Bohseidai, Isehara, Kanagawa 259-1193, Japan
Tel: 0463-93-1121 Fax: 0463-93-9387

UVB was given to separate areas of the back of the patient. In addition, visible light was irradiated for 10 minutes on the back of the patient using a slide projector lamp (780 W, Rikagaku Seiki, Tokyo, Japan) from a distance of 15 cm.

2) Action and inhibition spectrum test: Using a monochromator (JASCO, Tokyo, Japan), effective wavelengths were investigated by irradiating the dorsal region of the patient for 20 minutes in an irradiation range of 301-699 nm with a 33 nm step. Following the development of wheals, the inhibition spectrum was examined at 301-699 nm.

Heat tolerance test: Both hands were soaked in warm water at 40 ˚C for approximately 10 minutes.

Serological tests

1) *In vitro* serum test: Serum derived from the patient was irradiated in a test tube using a slide projector lamp at a distance of 15 cm for 10 minutes and injected intracutaneously into the left upper arm of the patient (Fig. 1).

2) Reverse *in vitro* serum test: Following 10 minutes of the irradiation with a slide projector lamp, the patient's serum was irradiated at 533 nm for 20 minutes and injected intracutaneously into the patient (Fig. 1). We tentatively designated this approach as "reverse *in vitro* serum test".

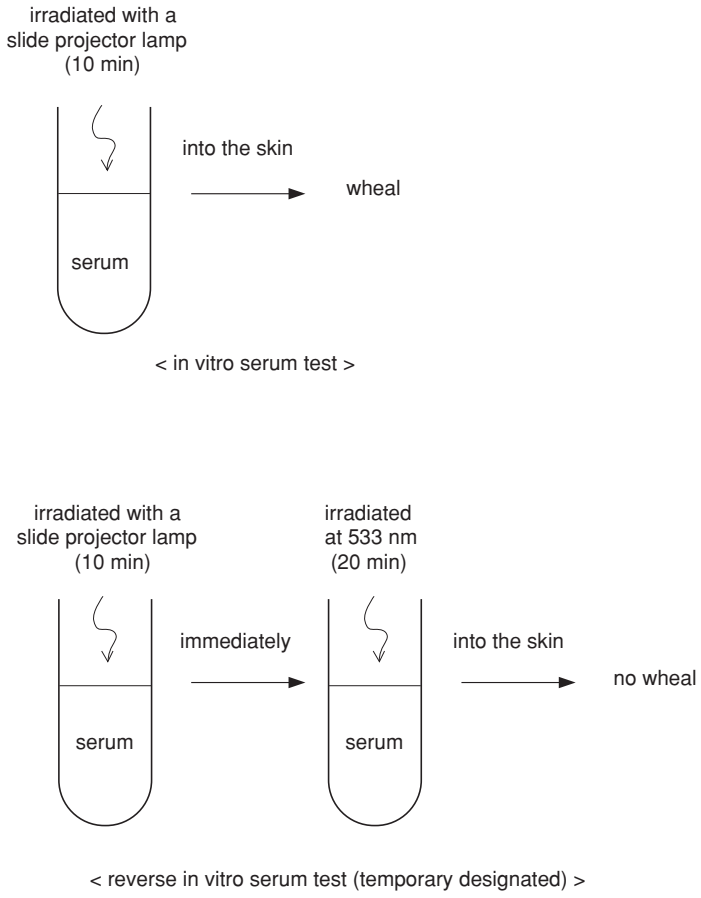

Fig. 1 Schematic illustration of the *in vitro* serum test.
The patient's serum was irradiated for 10 minutes using a slide projector lamp at a distance of 15 cm and injected into the left upper arm of the patient (*in vitro* serum test). Inhibition of wheal forming activity was examined by exposing the above irradiated serum at 533 nm (tentatively designated as "reverse *in vitro* serum test).

RESULTS

Light irradiation test

Erythema was not recognized after UVA irradiation, whereas definitive erythema appeared 48 hours after UVB irradiation at 0.04-0.1 J/cm^2. Minimal pigmented dose (MPD) and minimal erythema dose (MED) were both within normal ranges. Upon irradiation with a slide projector lamp, erythema appeared 5 minutes after the initiation of irradiation and, after 6 minutes, wheals developed. Erythematous reaction was maximum 20 minutes after irradiation and faded within 60 minutes. Wheals disappeared 12 minutes after irradiation (Fig. 2).

Action and inhibition spectrum test

Wheals were recognized in the region irradiated at 433-499 nm (Fig. 3), and suppression of wheals occurred in the region irradiated at 533 nm (Fig. 4). These findings suggest that the action spectrum was 433-499 nm and the inhibition spectrum was 533 nm.

Heat tolerance test

No wheal was recognized even after 10 minutes of thermal exposure.

In vitro serum test

Upon intracutaneous injection of the serum exposed to visible light, a distinct wheal with 10 mm of diameter was observed (lower arrow) (Fig. 5), whereas non-irradiated serum caused no recognizable changes (upper arrow) (Fig. 5).

Reverse *in vitro* serum test

The patient's serum exposed to visible light was further irradiated with the inhibitory wavelength of 533 nm and injected into the left upper arm. No wheal developed with either non-irradiated serum (upper arrow) or serum irradiated sequentially with visible light and 533 nm ray (Fig. 6).

DISCUSSION

The action spectrum of solar urticaria reported in Japan distributes mainly in the visible light range [6], while in the United States and Europe, it is frequently in the ultraviolet range. The inhibition spectrum has been described in 23 cases in Japan [4, 5]. These reported inhibition spectra were in the visible light range and always longer than the action spectrum in every case. In the present case, the action spectrum was also in the visible light range of 439-499 nm and the inhibition spectrum was 533 nm, which was longer than the action spectrum. Harber [7] classified solar urticaria into 6 types according to the action spectrum and the results of the transfer test. Because of possible infection, neither passive transfer

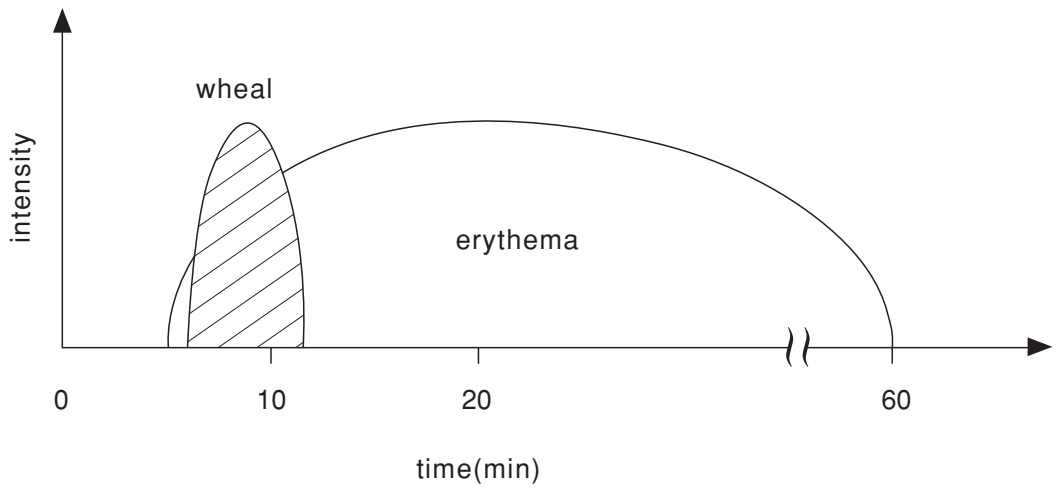

Fig. 2 Time course of erythema and wheal development. Erythema developed 5 minutes after the initiation of the irradiation and wheals appeared 6 minutes after the irradiation. Erythematous reaction was maximum 20 minutes after the irradiation and faded within 60 minutes. Wheals disappeared 12 minutes after the irradiation.

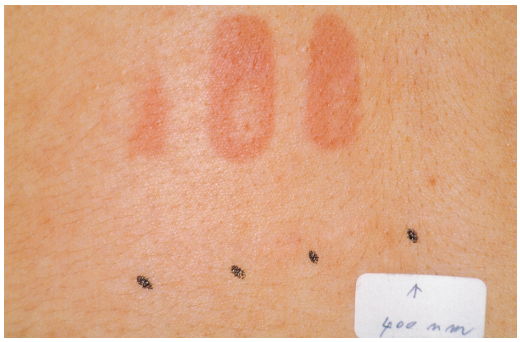

Fig. 3 The action spectrum.
Upon 20 minutes of irradiation with a monochromator, wheals developed at 433-499 nm. From the left, irradiation wavelength was 499 nm, 466 nm, 433 nm, and 400 nm.

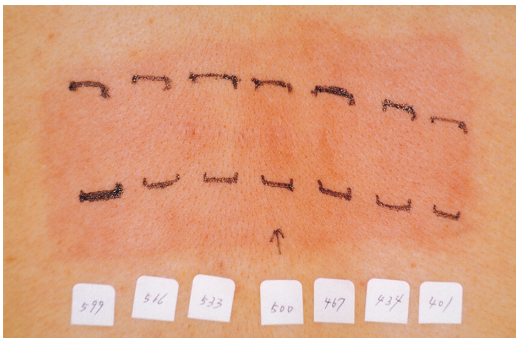

Fig. 4 The inhibition spectrum.
Wheal induction by visible light irradiation was suppressed by 20 minutes of irradiation at 533 nm using a monochromator. The numbers indicate the irradiation wavelength in nm.

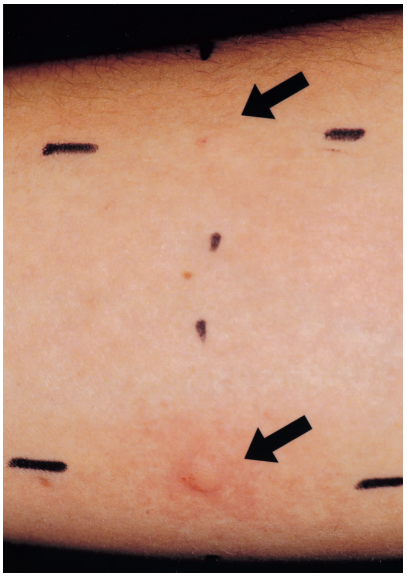

Fig. 5 *In vitro* serum test.
In the upper arm, the patient was injected intracutaneously with aliquots of the patient's serum, either non-irradicated (upper arrow) or irradiated (lower arrow) for 10 minutes with a projector lamp from a distance of 15 cm. Wheals developed with the irradiated serum.

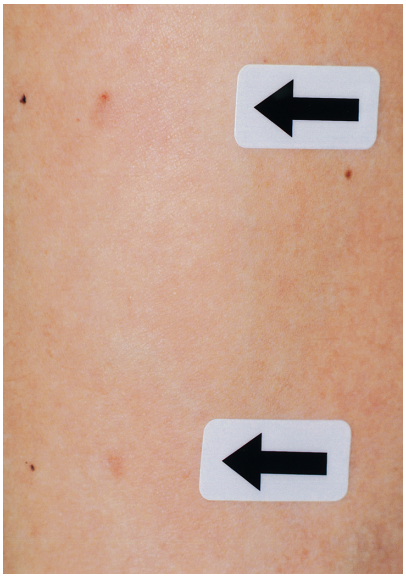

Fig. 6 Reverse *in vitro* serum test (tentative designation).
The patient's serum was either non-irradiated (upper arrow) or irradiated sequentially with visible light and the inhibition spectrum of 533 nm (lower arrow) and injected intracutaneously into the upper left arm of the patient. No wheal developed with either serum.

test nor reverse passive transfer test was carried out in the present study. Therefore, modification of Harber's classification (Table 1) [8-10] was applied. According to this classification, our present case falls under type IV, which is common in Japan. The patient was prescribed epinastine hydrochloride (Alesion®) orally for 49 weeks. We compared the light sensitivity before and after the treatment. Before the treatment, wheals appeared 6 minutes after irradiation. After the treatment, wheals devleoped 12 minutes after

Table 1 Modified Harber's classification [8-10]: Our case was type IV.

Type	Action spectrum (nm)	Inhibition spectrum (nm)	Passive tansfer test	Reverse passive Transfer test	Serum Factor	Mechanism
Our case	433-499	533	No examination	No examination	+	Probably allergic
Ⅰ	285-320	?	+	+	?	Allergic
Ⅱ	320-400	−	−	−	−	Unknown
Ⅲ	400-500	+	−	−	−	Unknown
Ⅳ	400-500	+	+	−	+	Probably allergic
Ⅴ	280-500	?	−	−	?	Unknown
Ⅵ	400	+〜−	−	−	?	Porphyrin body

irradiated visible light using a slide projector lamp. Thus, the latent period prolonged approximately 2-fold after the treatment. Since no appropriate sunscreen for visible light is commercially available, we adviced the patient to minimize sun exposure.

It has been considered that solar uriticaria is caused by an allergic mechanism and photosensitizing chemicals [6]. Horio *et al*. [11] proposed the following series of reactions.

1. Chromophore in the skin absorbs photoenergy and produces photo-antigen;
2. Photo-antigen binds to the antibody on mast cells;
3. Degranulation of mast cells occurs, releasing chemical transmitter (s);
4. Chemical transmitter (s) cause vasodilation;
5. Wheals develop.

Horio *et al*. [11] described a case of solar urticaria in whitch wheals were induced by intracutaneous injection of the patient' s serum following irradiation with action spectrum *in vitro*, while this wheal forming activity was suppressed by irradiation with inhibition spectrum. In our case, wheal formation was inhibited completely. The *in vitro* serum test and tentatively designated "reverse *in vitro* serum test" were both positive, suggesting the existence of chromophore in the serum. Further case studies are required for thorough understanding of solar urticaria.

Part of this study was presented at the 758th meeting of Japan Dermatology Association in Tokyo district on October 28, 2000.

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