The Effect of UV-Light on Human Skin Microorganisms

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Pityrosporum orbiculare, Candida albicans, Staphylococcus epidermidis and *S. aureus* were irradiated with UVA and UVB light in vitro. UVB inhibited growth much more effectively than UVA. *P. orbiculare* was the most sensitive and *S. aureus* the least sensitive organism. With a dose of 900 mJ cm^{-2} of UVB a 50 times reduction in number of colony forming units was seen for *S. aureus* and for the other organisms a total inhibition of growth was seen. When *P. orbiculare* was irradiated with monochromatic light at 300, 330 and 360 nm the highest antimicrobial activity was seen at 300 nm. If these in vitro observations correlates with the effect of UV-light treatment of various skin disorders is still unclear. (Received August 28, 1986.)

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UV-irradiation is effective in killing many microorganisms in vitro (1, 2). Psoralen and exposure to long wave ultraviolet irradiation (PUVA) has a lethal effect on many microorganisms in vitro (3). In a study by Weissmann and Noble no effect was seen on the cutaneous aerobic bacteria after PUVA treatment in 10 patients with psoriasis (3). Frequent sunbathing does not greatly affect the total number of microorganisms on the skin (4). *Candida albicans* is used for phototoxicity studies of various drugs (5, 6) and Mitchell has shown that even microorganisms may contain products phototoxic to other microorganisms (7).

In the present investigation the effect of various wavelengths and dosages of UV-light in vitro on *Pityrosporum orbiculare, Candida albicans, Staphylococcus epidermidis* and *S. aureus* was studied.

MATERIALS AND METHODS

Test organisms. *P. orbiculare* ATCC 42132 and 44341, *C. albicans* H 29, and, *S. epidermidis* CK and *S. aureus* 176, kindly submitted by Professor Lars Edebo, Department of Clinical Bacteriology, University of Gothenburg, were used. *P. orbiculare* was grown on a glucose-neopeptone-yeast extract agar medium containing olive oil (20 ml l^{-1}), Tween 80 (0.2 ml l^{-1}) and glycerol monostearate (2.5 g l^{-1}) earlier described (8). *C. albicans* was grown on Sabouraud's agar medium and *S. epidermidis* and *S. aureus* on blood agar. The microorganisms were suspended in phosphate buffered saline (PBS), pH 7.4 to give solutions containing 10^3 cells ml^{-1}.

Irradiation technique. The microorganisms were irradiated with both UVB and UVA. Philips TL12 was used as a UVB-source and Mutzhas UVA-SUN 2000 for UVA irradiation. For wavelength studies a monochromator, Clinical Photoirradiator (Applied photophysics) was employed. UVB irradiation was measured with an International light IL 1350 SED 240 probe and UVA with an International light IL 1350 SED 015 probe. UV intensities for the monochromator were measured with a thermopile.

When Philips TL12 UVB lamp was used 0.3 ml of the test organisms were spread with a bended glas rod on the appropiate medium and irradiated with doses from 65 to 900 mJ cm^{-2}. Control plates were not irradiated. Plates were then incubated at 37°C. *C. albicans, S. epidermidis* and *S. aureus* were read after 24 h and *P. orbiculare* after 3 days.

With Mutzhes UVA-SUN 2000 the experiment was done as described for UVB and the test plates were irradiated with doses from 25 to 75 J cm^{-2}. With the monochromator only *P. orbiculare* ATCC 44341 was tested. The result of irradiation at wave-lengths of 300, 330 and 360 nm was studied. Plates were incubated on 5 to 8 different spots with one drop (20 µl) of the cell suspension. The spots were irradiated with increasing doses of light. At 300 nm ±5 the doses were 10–1280 mJ cm^{-2}, at 330 nm ±20 the doses were 2.5–40 J cm^{-2}, and at 360±30 nm the doses were 5–80 J cm^{-2}. Control plates were not irradiated. After the experiment plates were incubated at 37°C for 3 days.

Statistics

The Student's *t*-test for unpaired samples was used to compare the number of colony forming units before and after irradiation.

RESULTS

The results of UVB irradiation with Philips TL12 are shown in Table I. *P. orbiculare* was the most sensitive organism but also for *C. albicans* no growth was present at a dosage of 250 m J cm^{-2}. For *S. epidermidis* and *S. aureus* the reduction in growth was only ten times until the highest UVB-dose. Here the growth of *S. epidermidis* was completely inhibited and the growth of *S. aureus* was reduced to 52 colony forming units compared with 2.2×10^3 for the control.

Table II shows the results of UVA irradiation with Mutzhas UVA-SUN 2000. The number of *P. orbiculare* was significantly reduced but for the other organisms the reduction in number of colony forming units was not significant.

Table I. *Results of UVB irradiation with Philips TL12 on Pityrosporum orbiculare, Candida albicans, Staphylococcus epidermidis and S. aureus*

	UVB (mJ cm^{-2})				
	65	123	250	900	Control
	(number of cells)				
P. orbiculare					
ATCC 42132	320	100	0	0	2500
ATCC 44341	621	20	0	0	1800
C. albicans H 29	2 100	1 800	0	0	2500
S. epidermidis					
CK	260	180	130	0	2800
S. aureus 176	2 200	460	230	52	2200

Table II. *Results of UVA irradiation with Mutzhas UVA-SUN 2000 on Pityrosporum orbiculare, Candida albicans, Staphylococcus epidermidis and S. aureus*

	UVA (J cm^{-2})			
	25	50	75	Control
	(number of cells)			
P. orbiculare				
ATCC 42132	2 500	1 100	20	2 500
ATCC 44341	350	10	1	2 000
C. albicans H 29	ND	4 800	4 100	5 200
S. epidermidis CK	ND	3 100	920	3 100
S. aureus 176	ND	2 100	830	2 500

Table III. *Results of monochromatic irradiation at 300, 330 and 360 nm on Pityrosporum*

Irradiation at 300 nm (mJ cm^{-2})								
10	20	40	80	160	320	640	1 280	Control
Number of cells								
250	250	250	250	250	30	0	0	250
Irradiation at 330 nm (mJ cm^{-2})								
2.5	5	10	20	40				Control
Number of cells								
260	260	100	10	0				260
Irradiation at 360 nm (mJ cm^{-2})								
5	10	20	40	80				Control
Number of cells								
220	220	220	220	100				250

Results of UV-irradiation with the monochromator, Clinical Photo-irradiator (Applied photophysics) at 300, 330 and 360 nm are shown in Table III. Again the reduction in number of cells was most pronounced at the shortest wave lengths.

DISCUSSION

High doses of UV-light are antibacterial and may be used for sterilization (1, 2). UV-light at 254 nm was found to effectively inhibit the growth of *Escherichia coli, S. aureus, Shigelli sonnei* and *Sh. typhi* (1), but this type of radiation does not reach the surface of the earth. However, it can be obtained from UV-fluorescent lamps. Many earlier studies were done to investigate the sterilizing effect of short wave UV-light or the use of microorganisms for phototoxicity testing (5, 6, 7).

The aim of the present study was to investigate the effect of physiological doses of ultraviolet radiation in vitro. The most effective antimicrobial activity of UV-light was found with UVB. This wavelength range has more effect on the DNA than UVA. Thus, thymin dimers are more easily formed. At the highest dose of UVB only *S. aureus* survived. Patients undergoing phototherapy will often be exposed to doses of 250 mJ cm^{-2}. However 900 m J cm^{-2} is rarely achieved. For UVA only *P. orbiculare* was sensitive. Seventy-five Joule of UVA can easily be obtained in Sweden after one day of sun exposure. With the monochromator the same results were found but the reduction in number of *P. orbiculare* cells at 360 nm was only 2 times. Even if UV-light has an antimicrobial effect in vitro this may not always correlate to in vivo conditions as found by Weissmann & Noble in a study of psoriasis treatment with PUVA (3). It will be interesting to look at patients with various skin diseases treated with UV-light and to see if there is any correlation between effect of treatment and the kind and number of organisms.

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Irritation and Staining by Dithranol (Anthralin) and Butantrone (10-Butyryl Dithranol): Further Short Contact and Tape Stripping Experiments

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Göransson A. Irritation and staining by dithranol (anthralin) and butantrone (10-butyryl dithranol): further short contact and tape stripping experiments. Acta Derm Venereol (Stockh) 1987; 67: 72–76.

Ten psoriatics were tested with three concentrations of butantrone (0.66, 2.0 and 3.9 %) on the healthy skin of the back and the irritant and staining reactions were compared with those produced by 0.1 and 0.5 % dithranol, both in white petrolatum. Of the three test areas one was stripped before exposure to simulate the penetration of a psoriasis lesion, one after exposure to simulate posttreatment washing and one was unstripped. The contact times were 20 and 60 min. The degrees of erythema and staining, and the increase in skin blood flow were measured 1, 2, 3 and 7 days after application. Both dithranol concentrations produced a markedly stronger increase of blood flow and erythema than any of the butantrone concentrations and a clear dose response when the concentration was raised from 0.1 to 0.5 %. Such a dose response was not clearly seen with butantrone. Staining with both dithranol and butantrone was minimal. Apparently, higher concentrations of butantrone than dithranol can be used in short contact therapy if cumulation of the drug can be excluded by a short contact time and careful removal of the surplus drug. *Key words: Psoriasis; Short contact therapy.* (Received May 30, 1986.)

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Dithranol (anthralin) has maintained a key place in the topical treatment of psoriasis (1). In conventional formulations like Lassar's paste, dithranol is effective but messy and unacceptable for continuous use by out-patients. Recently the use of high concentrations of dithranol for less than one hour daily, the so-called short contact or minutes therapy, has made possible the use of dithranol by out-patients also (2, 3).

Previous studies have shown that 10-butyryl dithranol (butantrone) retains antipsoriatic activity (4) but causes less irritation and staining of healthy-looking or stripped skin than