ORIGINAL ARTICLE

Phototesting with a new digital targeted UV phototherapy in skin phototype IV and V

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ABSTRACT

Background: Assessing minimal erythrma dose (MED) and minimal phototoxic dose (MPD) is important to determine the starting dose of patients being treated with phototherapy, especially when using the targeted phototherapy which reduces the unnecessary exposure of uninvolved skin.

Objectives: To assess MED and MPD tests using a commercial digital phototherapy skintrek PT3 in skin type IV and V and to determine whether skintrek PT3 is reliable, useful and capable to assess MED and MPD.

Methods: Twelve healthy volunteers were included in this study. MED and MPD were done using the digital photoherapy device skintrek PT3.

Results: Twelve healthy volunteer were recruited with Fitzpatrick skin type IV, n= 5; V, n=7. The average MED is 0.53 J/cm^2 (0.27 J/cm^2 to 0.74 J/cm^2) for skin type IV, and 1.83 J/cm^2 (1.45 J/cm^2 to 2.02 Jcm^2) for skin type V. The average MPD is 2.88 J/cm^2 (1 J/cm^2 to 4.5 J/cm^2) for skin type IV, and 5.5 J/cm^2 for skin type V (5.5 J/cm^2 to >6.5 J/cm^2)

Conclusions: The results of the present study, assessing MED and MPD using the new skintrek, indicate that MED and MPD can be easily and accurately obtained using the new digital phototherapy skintrek PT3. Also, it seems to be both reliable and useful device.

KEY WORDS: Digital UV therapy; minimal erythrma dose; minimal phototoxic dose; UVB; topical PUVA

INTRODUCTION

A number of targeted phototherapy devices have been developed over the years to provide treatment for patients with skin disorders such as psoriasis, eczema and vitiligo. It involves the delivery of ultraviolet radiation directly focused on the diseased skin lesions, while avoiding clinically normal skin. It also allows the use of lower number of treatment sessions than the full body phototherapy.[1-4]

This was established to avoid the side effects of phototherapy with significant long-term adverse effects that are dose related. These effects of ultraviolet radiation when it interacts photochemically with skin tissues are classified as acute and chronic. The acute effects of UVR are short term and usually reversible. Such as sunburn, tanning, immunosuppression and photosensitivity. While the chronic effects that are dose related are skin cancers, photoaging like wrinkling, depigmentation, telangiectasia and actinic keratoses on exposed skin.[5-8]

The dosage of UV lights is prescribed according to an individual skin sensitivity. This variation is because of skin pigmentation, skin thickness and other factors. Thus to establish the proper dosage of UV light as starting dose for the patients, is done either by determining skin phototype, or by using MED (Minimum erythema dose) and MPD (minimum photoxic dose) methods.

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The MED is defined as the lowest dose (expressed in joules per square meter) that produces a perceptible redness reaction at 24 hours (this definition is used in the U.K; In the U.S.A, the MED is defined as the lowest dose of UVR causing redness with a definite border). MPD prior to photochemotherapy with psoralen-ultraviolet A (PUVA). The advantages of these tests are to determine whether Psoralen in MPD test was adequately absorbed, to detect photosensitivity disorders, to decide the starting dose to avoid higher cumulative exposure, and to avoid overdose and under dose of UV and minimize incidence of adverse effects.[10]

For determination of the MED and MPD, different doses of UVR, usually in a geometric series, are applied to uninvolved skin of subjects and the visible reaction of the skin is recorded at 24 hours for MED test and 72 hours to 96 hours for MPD test.[11] MED and MPD assessment represent the gold standard for determination of starting dose for phototherapy treatment protocol.

By using the MED assessment method, some studies show that high skin phototypes tolerate UVR more than low skin types.[12,13] However, other studies show that there is no or little relationship between skin phototype and MED.[14,15] The degree of erythema depends on a host of factors such as hydration, age, site of erythema and skin phototype.

In this paper we assess MED and MPD test using targeted skintreck in highly pigmented skin.

METHODS

Patients: MED and MPD were assessed in 12 healthy volunteers visually using the new skintrek PT3.

UV Irradiation skintrek PT3 and procedure: A commercial digital phototherapy skintrek PT3 (LUMEDTEC GmbH, Lüneburg, Germany) (Fig. 1) was used in this study. The instrument was calibrated by the manufacturer within 6 months of the starting of the study.

The light source used in this was a mercury short-arc lamp with electrical output of 200 W. The optical power of these lamps ranges across a wide light spectrum, from ultraviolet radiation to visible light. The emission spectrum is between 285 nm and 350 nm (Fig. 2).

The skintrek technology is continuous rays of a source of UV light which is a mercury short-arc lamp with electrical output of 200 W, will be bundled through an optic (Condenser) and according to requirement or settings filtered in a way that either UVA-rays with a spectrum of 320 nm – 400 nm or UVB-rays with a spectrum of 300 nm – 320 nm reach the digital light modulator (DMD, Digital Micro Mirror Device). The DMD then will digitize the continuous ray of light into approximately 800.000 single rays (“Pixelrays”). These pixelrays are projected onto the skin surface and have a size of about 0.14 mm X 0.14 mm. On the database of an image recognition combined with a calculation of the dose, only the rays that hit diseased areas of skin (lesions) will be activated. The light modulator (DMD, Digital Micro Mirror Device), is a micromechanical semiconductor device consisting of a matrix of 768 X 1024 tiny mirrors, of which each has a size of about 11 µm and each can mechanically be tilt by ± 12°.

This targeted UV machine have the ability to dose both UV testing to determine MED and MPD by the same machine, but not at the same time. All phototesting irradiation processes are automatically recorded. The UV source was

positioned with a distance against the skin of the volunteer by the operator. If the volunteer moves, the machine will automatically (have the ability to detect and track any small movement) go back to the test area within fractions of a second. Because, the machine had automated lesion detection and there is no need to hold the tester on the same place during phototesting. The end of irradiation is indicated by a beep, and the lamp switches off automatically.

Each volunteer had two phototests: one MED test and one MPD test using UVB and UVA irradiation. For MPD test a rectangular area on the skin of the back painted locally with 0.01% methoxsalen local paint (Ultrameladinin 0.03 g/15 ml, Memphis Co. For Pharm. & Chemical Ind., Cairo, Egypt) 20 minutes prior to UVA iiradiation. This concentration was prepared by simple dilution by adding 50 ml of methoxsalen to 1 L of 95% isopropyl alcohol. This concentration is used in phototherapy unit, As'ad Al-Hamad Dermatology Center, Sabah Hospital, Kuwait.

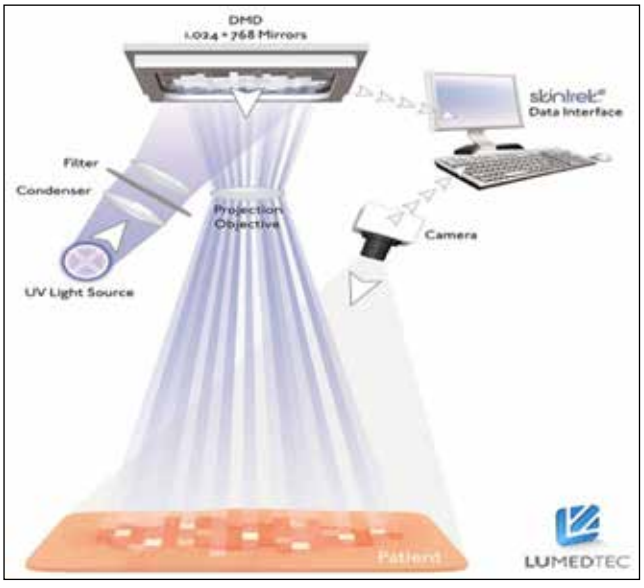

Fig. 1 Schematic of components of skintrek PT3.
This picture is taken from http://downloads.german-pavilion.com/downloads/pdf/exhibitor_32673.pdf

Fig. 2 Skintrek PT3.
This picture is taken from http://www.filsat.pt/lumedtec?lg=2

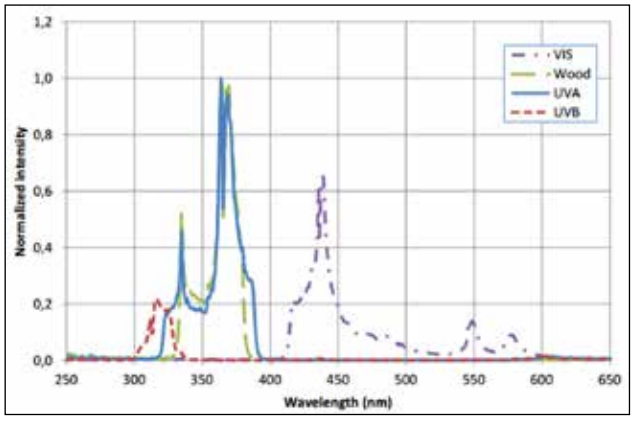

Fig. 3 Emission spectrum of sbUVB and UVA.
This graph is taken from the operation manual for PT3 by contacting the local distributor

The 12 volunteers were given a different doses series of UV exposure. There was no change in the output of the UV irradiation lamp, so the time was the same during the study. That was because this study was started with a new machine.

The test was done on the skin of the upper back and at least one inch away from the spine as much as possible. The site of testing area was shaved if necessary to minimize reflection of light during ultraviolet exposure. Ink mark was used in each corner of the exposed areas so the test area can be identified easily.

The device automatically exposed 6 different

doses of UV in the skin, allowed a set of 6 doses of UVB or UVA to be given by 1 timed application. A geometric series of doses was given with a constant ratio between successive doses of approximately $\sqrt{2}$

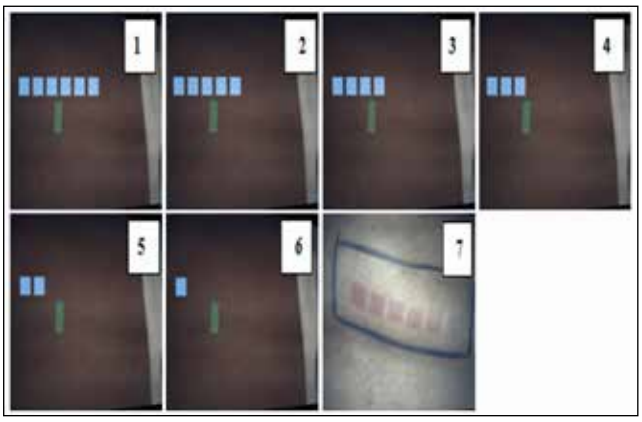

Fig. 4 Image of MED phototesting procedure.

The MED was visually assessed after 24 hours. The MED (Minimum erythema dose) is defined as a lowest dose (expressed as Joules per square meter) that produces a perceptible redness reaction at 24 hours. The test site for each dose was outlined with a skin marker pen so that they could be identified for later assessment.

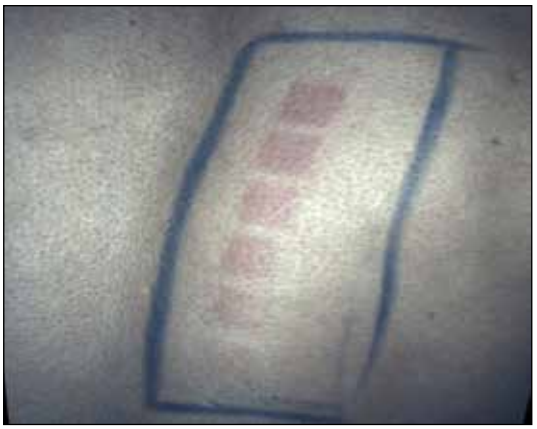

Fig. 5 Image of UVR dose response series 24 hours after UV irradiation for volunteer no 3. The white arrow represents the minimal erythema dose. The black arrows represent the highest dose.

STATISTICAL ANALYSIS

Microsoft Excel 2007 was used for statistical analysis. The data was expressed as average, minimum and maximum.

RESULTS

A total of 12 healthy volunteers (9 male and 3 female; median age 37 years, [range 25 - 55]. Fitzpatrick skin type IV, n= 5; V, n=7) were enrolled in the study. Table 1 gives the characteristics of the volunteers.

Table 1 Summary of volunteers results with MED and MPD using Skintrek PT3K= Kuwaiti; N.K= Non Kuwaiti; M= Male; F= female; MED = minimum erythema dose; MPD= minimum photoxic dose.

No.	Patients Initial	Age	K/N.K	Sex	Skin type	MED	MPD
1	SH	42	N.K	M	V	>1.45	5.5
2	FA	38	N.K	M	V	2.02	>6
3	SS	36	N.K	M	V	1.45	>6.5
4	KA	36	N.K	M	V	2.02	>6.5
5	AM	37	N.K	M	V	1.45	>6.5
6	SB	45	N.K	M	V	2.02	>6.5
7	RS	45	N.K	M	V	2.02	>6.5
8	MO	55	N.K	M	IV	0.74	2.5
9	OS	29	N.K	M	IV	0.38	1
10	MA	35	K	F	IV	0.74	>3
11	KM	27	N.K	F	IV	0.27	3.5
12	FB	25	K	F	IV	0.53	4.5

Average MED 1.24 (0.27 -2.02) for all volunteers. Minimal erythema doses for the volunteers with skin type IV ranged from 0.27 J/cm^2 to 0.74 J/cm^2 with average of 0.53 J/cm^2. While, in skin type V it ranged from 1.45 J/cm^2 to 2.02 J/cm^2 with average 1.83 J/cm^2. Average of MPD was 2.88 (1 – >6.5)

Minimal photoxic doses for the volunteers with skin type IV ranged from 1 J/cm^2 to 4.5 J/cm^2 with average 2.88 J/cm^2, while skin type V ranged from 5.5 J/cm^2 to >6.5 J/cm^2 with average 5.5 J/cm^2 .

To compare between skin types, we used a non-parametric Mann-Whitney Test (as we had small sample size). P-values showed that there was no significant difference in MED and MPD between skin types (P = 0.73 and P=0.56 respectively)

DISCUSSION

There is an increasing need for photobiologist to evaluate skin colour changes in human skin. To date, few data have assessed MED in highly pigmented skin, because visual detection is subjective and is affected by several unrelated factors such as viewing geometry, ambient illumination, colour of unexposed surrounding area, and also the experience and visual acuity of the observer. It is also very difficult to assess erythema in dark skin. Whereas, lower doses of UVR produce only a visible erythema, high doses of UVR may result in edema, pain, blistering and, after a few days, peeling.

Sun reaction skin types as determined by questioning the subject, are one system for assessing the UV sensitivity of subjects. However, it is a crude system and does not correlate highly with the assessment of the sensitivity by direct determination of MED, because the Fitzpatrick skin type scale is subjective and dependent on the questioning of volunteers which may vary between researchers. By using the MED assessment method, some studies show that high skin types tolerate UVR more than low skin types.[12, 13] However, other studies show that there is no or little relationship between skin type and MED.[14, 15] The degree of erythema depends on a host of factors such as hydration, age, site of erythema and skin type. To my knowledge only two studies has used skintrek PT3 for treatment[16,17] and no study assessed MED and MPD in dark skin. This study has shown that MED and MPD are higher in skin type IV than V.

On the other hand, phototesting most of the time are carried out using different device of phototherapy. Full body unit with same lamp type and with need for safety to be issued to cover all staff working in the vicinity of treatment unit such as protective clothing, cream or goggles.

The MED and MPD assessment do not appear to work quite as well for highly pigmented skin. This maybe because the skin typing does not accurately estimate UV sensitivity and has a limitation as a predictor of UV sensitivity. This is because it is difficult to distinguish the redness from background pigmentation and hence to evaluate redness in highly pigmented skin. It may also be that the degree of the redness may be underestimated in highly pigmented skin.

The results of the present study, assessing MED and MPD using the new skintrek, indicate that MED and MPD can be easily and accurately obtained using the new digital phototherapy skintrek PT3.

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