Biophysics of Shifting from Laser to UVB Phototherapy for vitiligo Treatment

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Abstract — The skin disorder named Vitiligo is supposed to be a curse specially for female. The white patches appearing on the skin are a great cause of worry and psychological stress and makes the patient’s life miserable. Vitiligo causes physical discomfort and inconvenience, it has been demonstrated that vitiligo influence the patient’s personal and social life, daily functioning and psychological status. Skin disease may provoke negative emotions such as shame or embarrassment, anxiety, lack of confidence and even psychiatric diseases like depression. The patients’ self-image may be profoundly depressed and his self-esteem threatened. Phototherapy is used for treatment of vitiligo. The Lasers used initially are now replaced by NBUVB light. The shifting of phototherapy from laser to NBUVB took place because of many reasons like cost, size of unit, side effects, results obtained etc. We have carried out case studies of phototherapy and analyzed the results.

Keywords — vitiligo, phototherapy, NBUVB, repigmentation.

I. INTRODUCTION

Why the normal skin colour changes to white? Even though the exact reason is not yet known studies describe it as a multi-casual disease, starting with the formation of a neoantigen, which triggers a cell mediated immune response leading to the destruction of melanocytes[3]. The depigmented lesions of skin and hair can be localized or generalized. It belongs to the group of the auto-immune disorders, e.g. Diabetes type I and thyroid disease, with which it is often associated. The prevalence is estimated at 0.5 to 1% worldwide, although in India a figure as high as 8% is reported. In the western world the quality of life (QOL) index scores in vitiligo patients are slightly lower than those of psoriasis patients. In the tropical region, where vitiligo was often confused with leprosy, patients with this disease are highly stigmatized. In India the QOL index scores of vitiligo patients supersede those of psoriasis patients[4]. Higher scores mean a lower quality of life. There are many possibilities for treating vitiligo but most preferable is phototherapy, except for a small number of patients with stable vitiligo, who can be treated with skin autologous pigment grafts.

II. METHOD

The skin has colour on account of melanin formation mechanism. To study the effect of radiation on the skin we have to start with how the skin responds to radiation? The optical properties of the skin can explain us the effects of exposure to radiation. From biophysics point of view the skin can be regarded as an inhomogeneous medium consisting of four layers: Layer 1 is Stratum corneum-Layer 2 is Stratum spinosum, These two layers form the outer layer Epidermis (50 - 150μm thick) incl. stratum basale Layer 3 is Dermis (0.8 - 1 mm) and layer 4 is Subcutis (1 - 3 mm). These layers have different refractive indices and distributions of chromophores, which will bring about different reflecting, transmission and scattering characteristics depending on the wavelength. Figure 2 gives a schematic representation of the skin layers and the depth of penetration as a function of the wavelength. The reflection of radiation in the 250-300 nm regions both against and in the stratum corneum is about 4-7%. Towards the longer wavelength the reflection of the skin increases. At about 800 nm there is a maximum reflection of 40-60% depending on the skin type. Going further towards the IR the reflection decreases to an average value of 5-10% in the IR-B region. The degree of reflection is also dependent on the melanin content; the darker the skin, the less the reflection decreases to an average value of 5-10% depending on the skin type.
result of interaction between the light and the particles according to the wavelength of the light. The attenuation of radiation in the epidermis is primarily due to absorption by chromophores and, secondly, by scattering. The chromophores in the stratum corneum are predominantly melanin, urocanic acid and proteins consisting of aromatic amino acids like tyrosine and tryptophan. The stratum malpighi, (= stratum basale plus stratum spinosum), consisting of viable cells (keratinocytes), has the same chromophores as the stratum corneum, but here the nucleic acids of DNA and RNA play an important role in absorbing short-wave UV. The absorption behavior and reaction of the skin to UV exposure differs considerably depending on the particular individual. Six skin types (four light-skin, two dark-skin types) have been defined in a commonly used international classification based on erythema formation and pigmentation capability of the skin when exposed to sunlight. The penetration of “light” into the dermis, because of the vascularization, is also influenced by the radiation absorbance of the blood (haemoglobin and oxyhemoglobin) in the 400-600 nm region and by the scattering of light by collagen fibers. In Figure 2 it can be seen that the greater part of UVC is absorbed in the stratum corneum (90%) and that 90% of the UBV is absorbed in the epidermis but that a considerable part of the UVA can reach the dermis which contains blood vessels. The thin epidermis has no blood vessels of its own, but receives what it needs from the capillary blood vessels immediately below the basal-cell layer of the epidermis. Light with a wavelength between 600 and 1400 nm (red light, short-wave infrared) can penetrate into the subcutis and is therefore called the “optical window” of the skin.

III. PHOTOTHERAPY

The first report of the use of “phototherapy” in the treatment of skin disorders dates from about 1400 BC among Hindus, as already mentioned. They used “photochemotherapy”-administration of plant extracts, followed by sun exposure-for vitiligo[1]. The same treatment was also used in ancient Egypt. The active ingredients in these plant extracts were isolated in 1947 by Fahmy et al.[5,6,7] as 8-methoxypsoralen (8-MOP) and 5-methoxypsoralen (5-MOP). In the same year, these authors and also El Mofty started to treat patients with vitiligo with 8-MOP and sun exposure[8]. Kromayer, a German dermatologist, designed in 1904 a water cooled mercury vapor UV lamp[9]. He was the first to treat vitiligo with artificial UVB. In 1969 Fulton et al.[10] used “black light” UVA tubes for the first time in combination with topical 8-MOP in the treatment of vitiligo. Parrish and Fitzpatrick introduced modern photochemotherapy with 8-MOP, having a peak sensitivity at 330 nm and UVA fluorescent tubes. They used fluorescent tubes emitting in the 320-380 nm waveband in the PUVA treatment of vitiligo[11]. Although late effects, e.g. skin carcinogenesis, have rarely been reported in vitiligo, the frequently observed phototoxic responses were considered a severe practical problem. Narrowband (NB)-UVB, or 311 nm UVB (Philips TL 01) has been used in the treatment of vitiligo now for 15 years and was first reported by Westerhof and Nieuweboer-Krobotova. It is now considered as the treatment of choice, because of its advantages over PUVA treatment being: UVB 311 nm is more effective than PUVA and safer, as there are no psoralen-induced side effects and can be used in children and pregnant woman. The NB-UVB can also be achieved with the eximer laser (308 nm)[12]. A drawback is that only small areas can be treated at one time and the eximer laser is excluded from home treatment. Narrowband UVB is also recommended in combination with pigmentcel grafting of vitiligo lesions[13]. Phototherapy is one of the most important therapeutic modalities in dermatology. This field has seen several major advances in the recent years [14] After a period of initial excitement, subsequent studies have led to a reappraisal of the role of excimer laser in psoriasis[15],[16] and vitiligo[17],[18][21] new low-level helium neon laser system (reported to be effective in segmental vitiligo). [19] It is obvious that both targeted laser and nonlaser phototherapies represent exciting advances in dermatotherapy. The VASI is a quantitative clinical tool that can be used to evaluate vitiligo parametrically. Patients treated with NB–UV-B can be expected to achieve approximately 42.9% repigmentation of their vitiligo after 6 months of treatment [20]
V. CONCLUSION
The NBUVB phototherapy is widely accepted as an effective treatment for vitiligo. The units in different shape and size are available in the field. The dose schedule is planned by the dermatologist and comparatively the cost of treatment is affordable. Laser units are limited in number and are rarely used for vitiligo treatment. The regularity and long duration of the treatment have given good results. Phototherapy is indeed a good treatment option for vitiligo patients of all the ages and vitiligo types.

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