SUN PROTECTION
THE FACTS AND THE BURNING CONTROVERSIES

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Despite the complexity of the oncogenesis in general and the photocarcinogenesis in particular, it is consensually accepted that actinic radiation is one of the main causes of skin cancer. The scientific arguments that support this concept are the increase of the incidence and prevalence of squamous cell and basal cell carcinomas in exposed skin areas, the increased incidence of these tumours in lower latitudes, and, in what the individual is concerned, his cutaneous pigmentation, outdoor activity and geographical area of origin. Experimental data also increasingly point to the responsibility of the ultraviolet B (U.V.B.) radiation in the etiopathogeny of these tumours, although, in what concerns malignant melanoma, the situation is to a great extent more complex.

Among the several types of actinic radiation that reach the earth surface, ultraviolet A and B (U.V.A. and U.V.B) radiation is considered the most significant in inducing malignant skin tumours. Nevertheless, there is increasing evidence of the potential oncogenicity of visible and infrared radiations. Ultraviolet C (U.V.C.) rays are totally retained in the ozone layer; as for the U.V.B., despite an important percentage being retained there, a relevant quantity still reaches the epidermal superficial layers, although only 1% is able to reach the deep dermis; on the other hand, the U.V.A., that were thought not to have a relevant role in tumoral genesis, appear today with a greater importance in inducing the most serious cutaneous malignancies, namely melanoma. This seems to result from their capacity to intensively reach the dermo-epidermal junction, deeply penetrate in the dermis and furthermore play a relevant role in inducing local and systemic immune suppression.

The three most important means of solar energy protection are natural protection, the protection achieved by the intake of systemic drugs and the protection resulting from the use of topic agents, broadly named sunscreens.

Natural Protection

Natural protection of each individual is assured by the queratinization process that regulates the thickness and the cohesion of the stratum corneum; the melanic pigmentation which occurs exclusively from eumelanin or black melanin (that disperses, absorbs and transforms photonic energy in heat or vibration and is also an active captor of free radicals); the cutaneous and subcutaneous accumulation of carotenes; the urocanic acid (a substance released in the sweat, synthesised from histidine and with the capacity to absorb actinic radiation); the anti-oxidant cutaneous system (superoxide dismutase, catalase, peroxidase and glutathione reductase) and by the sophisticated mechanisms of DNA repair and replication.

It is this genetically determined ability of defence from actinic radiation that allows us to classify the human being in six skin phototypes: ranging from phototype VI, of dark-skinned people, almost invulnerable to actinic radiation, who never get sunburned and are deeply pigmented, to phototype I, of extraordinary sensitive skins, who always get sunburned and rarely tan (for instance, associated with red-haired individuals). Between subtypes I and VI there are gradative variations that result, among other factors, from the quantitative existing relation between eumelanin – black melanin – with a defence ability, and pheomelanin – yellow melanin – that contains cistein and has the capacity to induce the creation of free radicals, therefore having a significant aggressive potential. The Mediterranean Caucasians, to which the majority of us belong to, are complex mosaics of both these melanins and are classified in phototypes III or IV.

Several authors consider the albinism as phototype 0. These patients are extremely sensitive to the sun, resulting from their genetic incapacity to synthesise melanin due to varied deficiencies of the enzyme tyrosine hydroxilase.

The clinic paradigm encompassing all these concepts and the genetic ability of defence from actinic radiation is xeroderma pigmentosum – an autossomic recessive disease based on a genetic defect in the enzyme mechanisms of DNA detection and/or repair, which leads to the development of successive, both benign and malignant, tumoral cutaneous lesions. One of these tumors, generally before the age of twenty, becomes more aggressive, creating metastases that lead to death.

The inefficiency of systemic protection

Several orally-taken drugs have been experimented, such as p-aminobenzoic acid (PABA) and p-aminosalicilic acid (PASA) (in an analogy with topic treatments), as well as triprolidine, unsaturated fatty acids and several vitamins (A, C, E). Only carotene, taken for four to six weeks, can induce a level of protection that does not exceed 2,5, being, nevertheless, from the preventive and therapeutic point of view, scarcely efficient.

Filters versus physical blockers

There are essentially two types of substances in topic agents: ultraviolet filters – p-aminobenzoic acid (PABA) and derivatives, benzophenones, benzimidazoles, camphor derivatives, cinnamates, salicylates, methylanthranilates, dibenzoylmethanates – photoactive chemical substances, capable of receiving and dispersing the radiation (in theory, since, like eumelanin, they transform photonic energy in vibration or heat). They are cosmetically pleasant and very effective against U.V.B. Against U.V.A. only benzophenones and dibenzoylmethanates present some ability of defence. However, against U.V.A. of long wavelength, i.e., above 370-380nm, none of them is effective. On the other hand, the physical blocking agents (titanium dioxide, zinc oxide, talc, magnesium salicylate, kaolin and others), that constitute a physical barrier to the penetration of U.V. radiation, do not have a privileged efficiency in any wavelength, and are cosmetically unpleasant. As long as they are formulated in adequate sizes of particles they are capable to inhibit, in an effective way, the penetration of all actinic radiation. Nonetheless, with the aim of making physical blockers more acceptable from

a cosmetic point of view, the pharmaceutical industry has been reducing the size of particles in general, and namely those of titanium dioxide and zinc oxide (for diameters below 30nm), providing the final preparation a spectre of absorbance quite similar to dibenzoylmethanates, with great efficiency for U.V.B., but without an effective protection capacity above 370-380 nm, that is for U.V.A. of long wavelength.

A few questions

The most pertinent questions from a technical, scientific and clinical practice-related point of view when dealing with sun protection are: 1) the methodology of protection factors determination; 2) the objective conditionings of the suggested protection factor; 3) the doubt over the existence of an effective U.V.A. protection and, in case of non-existence, its possible consequences; 4) the existence or non-existence of a co-relation between physiopathological paths of inducing the erythema and the changes conducting to delayed deleterious actions of U.V.

In what concerns U.V.B., it is, since long, consensual that the capacity to inhibit the erythema determines the protection factor of a certain formulation. In this sense, the protection factor or coefficient is the relation between the minimal dosage of erythema with photoprotector and the minimal dosage of erythema without photoprotector.

The consensus is taking longer to emerge when it comes to determining the U.V.A. protection factor. To achieve such goal, one can simply use erythema, the erythema induced by U.V.A. post-systemic administration of a photosensibilising drug – a psoralen, the immediate pigmentation induced by U.V.A. (I.P. – U.V.A.) and also delayed pigmentation (L.P. – U.V.A.).

In what protection factor conditionings are concerned, in other words, the real consonance between the suggested factor and the objective achieved protection, it is essential that the formulation of the sunscreen has substantivity (capacity to penetrate and fixate to the corneum stractum), remanence (capacity to resist water and sudation) and is photostable (is not degraded during solar radiation exposure, which substantially reduces its photoprotection capacity). On the other hand, it would be necessary to apply

34g of sunscreen each time – which is practically a whole tube – if one has into consideration the 1,7m^2 of corporal surface of an adult, to be able to reach the concentration of 2mg/cm^2, with which most tests for determining the protection factor are conducted. When applied "only" 1mg/cm^2 (17g of sunscreen for the corporal surface of an adult), the suggested protection factor decreases exponentially (for example, a protection factor 15 decreases to 3.9). In this sense, there is an almost total incapacity to achieve, in practice, the protection factor that is indicated.

There is indeed no efficient sun protection against U.V.A. of wavelengths between 370-380 nm, whether with physical agents composed by microparticles or with chemical agents currently available. The scientific arguments that allow us to conclude that there is no evident relation between inducing solar erythema and delayed deleterious actions from ultraviolets are quite substantial. For instance, indometacine is capable of inhibiting solar erythema, although not having any action in cellular changes induced by ultraviolet rays, while cimetidine, acting at an immune level, inhibits the photocarcinogenesis induced by U.V.B. in the rat, although not having any action at the erythema inducing level. Even sunscreens with great efficiency in preventing solar erythema have a null or reduced action in relation to the inhibition of local or systemic immune suppression induced by U.V.B.

Another notion that we consider of practical interest is that the classification of protection factors with levels superior to 15 is, according to us, incorrect and can only have commercial aims. A protection factor of 15 implies that our natural protection is amplified 15 times (i. e., only 1/15 (6,6%) of solar radiation is capable of penetrating the epidermis, 93,4% of it being absorbed or reflected). A protection factor of 30, that may appear to double the capacity of a protection factor of 15, means objectively that only 1/30 (3,3%) of the radiation can enter the cutaneous surface, 96,7% being retained. Thus, the difference between a factor 15 and a factor 30 is irrelevant from the point of view of its photoprotection capacity.

The controversies

Firstly, we shall go into the “epidemiologic polemic”. This is based in the fact that in a few Australian provinces sunscreens are used from the age of three, due to prevention campaigns apparently very well conducted, despite the increase of the incidence of the malignant melanoma – being Queensland, in the Northeast of Australia, the highest in the world. European studies corroborate this concern and show the increase of the incidence of basal cell carcinoma in women (1) and of melanoma in men (2, 3) that use sunscreens.

A second question can be presented as the “U.V.A. polemic”. Considering the relevant efficiency we have against U.V.B., associated with the difficulty against U.V.A. protection, the sunburn, which would function as a physiologic alarm bell to end or suspend sun exposure, does not occur, thus allowing an excessive exposure. Therefore sun exposures can be maintained, with apparent safety, for five hours – which, for instance in the summer and at our latitude, correspond to enormous dosages of U.V.A. (approximately of 100 J/cm2), which nobody knows the whole effect but that are, in the light of current knowledge, extremely damaging at the organic cellular and functional level.

Another debate is the fact that besides inducing changes at the DNA of all epidermal cells, ultraviolet radiation also induces local and systemic immune suppression, which, among other facts of physiopathological relevance, damages the whole oncologic system of surveillance. Further aggravating the situation, this photo-immune suppression is independent of the phototype and is not substantially altered by the use of sunscreens – chemical protectors. In what concerns physical blockers, there are no definite data, although less damaging results are expected as long as the size of the physical particles is adequate.

It should be underlined as well that during an effective sun protection against U.V.B. there is a reduction of serum concentrations of vitamin D and is therefore essential to offer supplements of this vitamin, particularly to the elderly.

Supported by evidence-based medicine, we must emphasise these polemic issues that seem to us relevant for a deep technical and scientific reflection and that basically question the fact that sunscreens should maintain their status as cosmetics or, if due to the questions they raise and the public health problems that might be implicated, should have the legal status of a drug.

On the other hand and for exactly the same reason, it should also be discussed legislation that prohibits the irradiation by U.V.A. in "tanning beds" or other cosmetic treatments without specialised medical control.

The future

In what concerns the future, the search for protections against U.V.A. as actives as the ones against U.V.B. should be a priority for scientific research. Ironically hats and swimming suits, these days so out-of-fashion, may well be part of the future of sun protection, as well as filters and physical blockers of medium and big particles, despite being cosmetically unpleasant.

We should make clear that in fighting against the increasing incidence of skin cancer, particularly melanoma that rises all over the world 7 to 10% per year, the most important is the timely recognition of suspicious lesions, the capacity to proceed to a diagnostic biopsy or promptly refer the patient to a specialised unit. Only in this manner will it be possible to fight this real epidemic that is currently malignant melanoma and for which the only adequate weapon is precocious diagnosis.

To help out, there is a mnemonic that synthesises the clinical characteristics of a cutaneous lesion suspicious of malignant melanoma, and that we designate as A, B, C, D, E of Melanoma: A – Asymmetry; B – Border Irregularity; C – Colour irregularity; D – Diameter over 8mm; E – Elevation.

In our opinion and at the stadium of current knowledge, the scientific truth is that a sunscreen is merely a modest support in the fight against skin cancer and that, in face of an overwhelming publicity, it is vital to dismount the false safety that its use can

transmit. In other words, it should be emphasised that the use of sunscreen is only useful if the exposure with its protection is as prolonged as it would be without it.

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