Sun Protection: Current Management Strategies Addressing UV Exposure

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KEYWORDS

• Sun protection • Skin cancer prevention • Photoaging • Sunscreen regulation • UV filters

KEY POINTS

- Sunscreen use can prevent the effects of photoaging and reduce the risk of skin cancer that is associated with ultraviolet exposure.
- All forms of sun protection in addition to sunscreen, including avoidance of exposure, physical protection, and seeking shade, should be emphasized to patients.
- A sunscreen should have a sun protection factor greater than 15 for ultraviolet B protection and for ultraviolet A protection should have a critical wavelength of 370 nm or greater in order to be considered broad-spectrum in the United States.

INTRODUCTION

It is well established that ultraviolet (UV) exposure plays a role in photoaging and certain types of skin cancer. It is important to understand what forms of protection exist against UV radiation and to be able to evaluate which sunscreens, when used as directed, can provide the most benefit to patients.

PHOTOAGING FROM SUN EXPOSURE

UV light can severely damage the skin and cause premature aging. Photoaging can be characterized by visible wrinkles, hyperpigmentation and uneven pigmentation of the skin, coarseness, laxity, telangiectasias, lentigines, and atrophy.[1–3] In 2013, Hughes and colleagues[4] published a randomized controlled trial to evaluate whether sunscreen could prevent the use of photoaging in adults younger than 55 years of age. Nine-hundred and three adults were randomized into 4 groups: daily use of broad-spectrum sunscreen and 30 mg of beta carotene, daily use of sunscreen and placebo, discretionary use of sunscreen and 30 mg of beta carotene, and discretionary use of sunscreen and placebo. Using skin surface replicas of the patients' dorsal hands, the study assessed changes in microtopography over 4 years in the sunscreen and beta carotene groups compared with control groups in a blinded fashion. Increases in microtopography are known to significantly correlate with risk for actinic keratosis and skin cancer.[5,6] Hughes and colleagues[4] reported that skin aging from baseline to the end of the trial was 24% less in the daily sunscreen group than in the discretionary sunscreen group (odds ratio, 0.76; 95% confidence interval, 0.59–0.98). It is important to understand the topical options available to patients for protection against photoaging in addition to counseling patients to avoid exposure altogether.

CANCERS ASSOCIATED WITH SUN EXPOSURE

It is also well known that UV radiation increases the risk for benign, premalignant, and malignant neoplasms on the face, neck, hands, and other areas of the body chronically exposed to the sun. Sun protection and the use of sunscreen are key

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to skin cancer prevention. According to the Skin Cancer Foundation, 90% of nonmelanoma skin cancers and 86% of melanomas are related to sun exposure and UV radiation.

This finding has been validated by many studies linking UV radiation with the molecular changes associated with skin cancer. p53 Mutations have been detected in nonmelanoma skin cancers from white patients in much higher frequencies (50%–90%) compared with internal malignancies. These mutations are predominated by the C:G → T:A mutation at dipyrimidine sites, namely the UV signature mutations.[7] There are other types of mutations seen in human skin cancers that are located in sun-exposed body sites that imply that oxidative DNA damage may also be implicated in photocarinogenesis.[8,9]

Almost all cases are preventable by avoiding exposure to UV radiation from sunlight and artificial sources.

DAMAGE FROM ULTRAVIOLET RADIATION

Although UV radiation can have positive effects on the skin, such an improvement of mood, increased vitamin D3 synthesis, and improvement in skin conditions such as psoriasis, UV radiation is mostly responsible for skin damage.[10] There are 3 different types of UV radiation that are classified by wavelength: UVA (315–400 nm), UVB (280–315 nm) and UVC (100 to 280 nm). UVC is germicidal, but does not reach human skin and is absorbed by oxygen and ozone in the atmosphere. UVA and UVB reach human skin and cause photodamage.

UVB is medium wavelength (280–320 nm) and cannot penetrate the skin as deeply as UVA rays can. Although most UVB radiation is filtered by the atmosphere, it is more energetic than UVA photons and contributes more to aging and cancer than UVA light does. It is more common in the summertime, and peak hours are between 10 AM and 4 PM depending on the location. UVB radiation mostly injures the epidermis and contributes to most acute sunburns. UVA radiation is present throughout the day regardless of season or the weather. UVA is therefore the longer wavelength (315–400 nm) and makes up 95% of the radiation that reaches humans and penetrates deeper into the dermis of the skin.[11–13]

UV radiation causes intracellular damage in multiple ways. UV light leads to the buildup of reactive oxygen species and inflammatory mediators, and inhibits the mitochondrial genome of cells and the ability of cells to repair themselves.[1] More specifically, UVA light is carcinogenic because it produces reactive oxygen species and induces the inflammatory signaling pathways.[9] UVA radiation can increase the presence of collagen-degrading matrix metalloproteinases, which can result in deeper wrinkles and loss of overall collagen.[14] UVB light damages DNA by forming covalent bonds between pyrimidine bases that have a high mutagenic risk.[15,16]

Overall, UV light cumulatively increases damage on a cellular level, increases melanin synthesis, decreases cell immunity, and is photocarcinogenic.

SUNSCREEN

History

Creams to protect the skin against sunburn first emerged in the 1940s. In 1944, Benjamin Green invented red veterinary petrolatum, a greasy material, in order to protect soldiers and himself against UV light in World War II. This substance mixed with cocoa butter and coconut oil as eventually developed into Coppertone suntan cream. In 1988, the US Food and Drug Administration (FDA) approved a sunscreen product called avobenzone, which is a UVA-only filter. Until that point, the only approved filters were UVB filters that incidentally had UVA protection.[17] The industry has now evolved; there are more than 30 different UV filters approved worldwide to protect against exposure to sunlight.[18] The FDA regulates the chemicals used in sunscreens and, as of 2012, has limited the claims for sun protection factor (SPF), how waterproof a product is, and the length of time it remains effective.[19] Thus, the United States still has far fewer protects approved by the FDA for market than the European countries do. For example, Tinosorb M and Tinosorb S (Bemotrizinol) are ingredients used for UVA protection, with peak absorption at 310 nm and 340 nm, that are not yet approved in the United States.[20,21]

Mechanism

Sunscreens should have certain basic features. They should be water resistant, hypoallergenic, photostable, and should not penetrate the skin. They should also have the ability to dissipate absorbed light energy without forming reactive intermediates or harmful byproducts.[22,23] Typically sunscreens contain both organic and inorganic UV filters that combined are broad-spectrum and protect against the entirety of the UVA and UVB range. UV filters are classified in 2 groups and many sunscreens today combine both types of filters in their formulations.

Organic Filters

The first group is chemical or organic filters that usually come in a liquid form. It is commonly