Revisiting Our Approach To Solar Protection: The Art of Thinking Broadly

David H. McDaniel, MD, FAAD
McDaniel Institute of Anti-aging Research, Virginia Beach, VA

Virginia L. Vega, PhD
SkinMedica®, an Allergan Company

“The general appearance of someone’s skin is influenced by a combination of the individual’s health, ethnicity, lifestyle, genetics and age. The mechanisms of skin aging are still not fully understood, although it is well-established that intrinsic and extrinsic factors play key roles. Unlike intrinsic aging, which is determined by genetic predisposition, extrinsic aging mainly depends on environmental exposures and lifestyle choices. The degree of unprotected solar exposure is one of the dominant environmental factors that promotes premature skin aging in all ethnicities, regardless of skin color. Solar radiation affects skin structure and function and superimposes upon preexisting chronological aging and other environmental injuries (e.g. smoking, tanning bed use, etc.). The extent of solar damage to the skin is directly related to the length, amount and dominant condition of the solar exposure (e.g. time of day, season of year, geographic location, etc.). Unprotected solar exposure not only promotes deleterious effects on skin quality but also increases the amount and degree of DNA alterations that may result in skin tumors.”

Unprotected solar exposure not only promotes deleterious effects on skin quality but also increases the amount and degree of DNA alterations that may result in skin tumors.

Solar light is composed of ultraviolet, visible and infrared (IR) rays (Figure 1). Among these, the most studied are UVA and UVB, though they only comprise 6.8% of the total solar radiation. The reason behind this apparent contradiction is simple: UV-photons (UVB>UVA) are the most energetic among the solar spectrum, producing large amounts of damage in short period of time. There is a growing interest in the cutaneous effects of the other solar radiation, such as visible and near infrared light. While IR photons have lower levels of energy, they account for 54.3% of the radiation that reaches human skin. IR-light is divided into near infrared (NIR, IRA) and longer wave infrared (IRB and IRC). IRA alone accounts for 30% of total solar radiation and reaches into deeper skin levels (hypodermis).

Solar induction of heat, that could reach levels close to or higher than 40°C, is also involved in skin aging.
Interestingly, the effects of thermal-aging were first documented in glassblowers and bakers. Both visible and IR rays increase skin temperatures, promoting extracellular matrix components degradation and Reactive Molecule Species (RMS) formation.

Although visible light also plays a role in skin damage, its role is less understood. The effect of low intensity visible light on skin cell functions is well-documented, though the mechanisms remain incompletely defined. Evidence showed that the ratio of visible and NIR light differentially modulates gene expression of human skin fibroblasts, producing both positive or negative effects on dermal matrix. FDA-cleared devices using these wavelengths in the mW/cm\(^2\) range can stimulate the production of dermal matrix proteins and to reduce inflammation. These in-office devices provide control over intensity, time of exposure, location and temperature during the procedure, resulting in a selective modulation of repair pathways improving aged skin.

**What are repercussions of blocking only one component of solar radiation (for example: UVR) and how important is it to provide broad solar protection?**

**Dr. McDaniel:** Solar radiation and heat trigger RMS formation, damaging membranes, nucleic acids, and proteins. Given the emerging data regarding both visible and IR light, it now seems prudent to try to protect skin from as much of the full spectrum of solar radiation as is practically feasible. A practical example to illustrate this concern is the “driver’s side window effect” which is well-known by clinical dermatologists. Increased skin wrinkling, fat volume loss and pigment dyschromia are often observed on the driver’s side relative to the opposite side of the face.\(^2,3\) We know that automobile window glass on the driver’s side typically filters out UVB light but allows transmission of UVA, visible and IRA light; so it makes sense at this time to not use selective UVB filters for solar protection when we have broader spectrum protection available. Since some broad spectrum filters lose their protection in the UVA range after a period of time, patients should understand the need to reapply those types of SPF in order to avoid overexposure of the skin to UVA. Also since no SPF blocks against 100% of the solar radiation, it also is prudent to include when possible agents that neutralize the RMS generated by the solar radiation that escapes SPF-linked mechanisms. Botanical antioxidants are a good choice for fulfilling this role and we are beginning to see these added to SPF as well.

**Figure 1: Solar radiations and skin damage. UVC is almost completely absorbed by the ozone layer.**
While “full spectrum protection” to defend the skin from solar radiation is our primary goal, it is increasingly possible to actually repair cellular damage. This was the rationale behind the creation of Total Defense + Repair (TDR) core technology that is powered by *Dunaliella salina*, *Physalis angulata* and *Polygonum aviculare* extracts (Figure 2). Repair of pre-existing damage is a unique capacity of these antioxidants that was evaluated using 3D human skin model (Figure 2). In brief, TDR SPF34 was applied immediately after UVR (damage was already induced) triggering an enhanced expression of DNA-repair enzyme: XPA1. Lower levels of XPA1 expression were observed in UV- radiated groups treated or not with SPF actives, suggesting that antioxidants in TDR are able to enhance repair mechanisms in response to injury resulting in a rapid return towards homeostasis.

**Could you describe the changes that you observed during the clinical testing of TDR SPF34?**

**Dr. McDaniel:** We conducted one of the pilot clinical trials to assess TDR efficacy in patients with moderate to severe photo-damage. In this study, 23 patients completed the study and they used once daily TDR SPF34 for up to 12 weeks. Investigator assessment and standardized digital photographs were obtained at week 4, 8 and 12. Two mm punch biopsies (n=5, crow’s feet area) were obtained at baseline and 12 weeks. There was reduction in fine lines and wrinkles as well as improvement in the skin texture in the TDR SPF34 group (see Figure 3). The skin biopsies also reflected repair changes such as thickening of the epidermis, increase in collagen deposition and decrease in MMP-1 staining, changes that can be attributed to the presence of antioxidants in TDR.

The relationship between solar radiation and skin cancer is well-established. Both UVA and UVB are able to trigger DNA damage that is repaired by two different mechanisms: NER (nucleotide excision repair system) or BER (base excision repair system). Levels of DNA damage can be evaluated using different markers: cyclobutane pyrimidine dimer (T-T dimers), phosphodiester breaks and expression of mutant p53 (mp53).

**Dr. McDaniel:** Different types of cancer are linked to a higher expression of mp53 proteins, which have lost the ability of wild-type p53 to suppress tumors and gained functions that contribute to malignancy progression. It is of particular interest that there was a reduction in mp53 protein detection observed with the antioxidant version of the SPF (TDR SPF34) suggesting that actual repair of the DNA damage had occurred.
Final Remarks

Dr. McDaniel: This is an exciting time to be involved in SPF research. We are not only learning so much new information about the impact of solar radiation on human skin, but also industry is able to translate the benchtop information to actual products that we can use on our patients and ourselves. I believe that we are just beginning to understand the true impact of the full spectrum of solar radiation for chronic exposure and that these interactions are much more complex than once thought. As we learn more, I believe multifunctional SPF which not only ‘protect and defend’ the skin from acute sunburn and chronic premature photo-aging but which secondarily block some of the free radical RMS damage as well as repair pre-existing damage will become the new standard for photo-protection.