

American Academy of Optometry

Position Paper on Ocular Ultraviolet Radiation

For Eye Care Practitioners and the Lay Public*

From the Section on Cornea, Contact Lenses, and Refractive Technologies

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Introduction

The human eye is highly susceptible to damage from both natural and artificial sources of toxic radiation such as Ultraviolet Radiation (UVR) which can be present at dangerous levels in ambient sunlight and certain man made light sources. UVR related ocular trauma and related diseases can occur in a number of tissues within the eye, ranging from the corneal surface right through to the retina, despite the inherent UVR protection in certain ocular media such as the crystalline lens and cornea.(1,2) UVR protection from shading headwear and certain designs of UVR-blocking sunglasses can reduce exposure but do not provide the complete ocular protection afforded by UVR-blocking contact lenses.(3) The design of UVR-blocking sunglasses and how they are worn are important in achieving optimal protection from these devices. Those providing a tight fitting wrap-around design, as opposed to small, flat, lenses mounted off the eye, will offer best protection, providing they adhere to the highest standard of inherent UVR-blocker in their lens material(4,5).

Ultraviolet Radiation

Correct color vision in humans requires a good balance of blue, green and red

light in the visible spectrum ranging from 400 to 700 nm in wavelength. The UVR waveband below 400 nm is divided into three distinct regions, defined by the Committee International d'Eclairage (CIE), all of which are toxic to ocular tissues, lower energy UVA (315 – 400 nm), high energy UVB (280 – 315 nm) and very high energy UVC (below 280 nm) which is not present in sunlight at the earth's surface when the ozone layer is undamaged. However, as the spectral range and overall daily dose of UVR can be detrimentally affected by increasing man-made climate change, the ocular toxicity of solar UVR may increase in future.(6,7)

The ambient solar UVR field is divided into direct rays from the sun and diffuse scattered rays incident on the eye from all directions, including surface reflections, that may enter the eye around shading and non-contact lens eyewear, particularly when the squint mechanism is switched off by shading and/or sunglasses(8,9). The ideal UVR-blocker should therefore transmit only visible radiation above 400 nm, filtering out all UVR wavebands incident to the eye from all directions, particularly for those who work outdoors in high solar intensities such as occur in the Southern United States (3) due to the latitudinal nature of UVR dose. While UVR related ocular disease can occur at any point on earth, epidemiological studies have shown that there is a noticeable increase in radiation intensity for locations closer to the equator and at increasing altitudes.(10) UVR ocular trauma may result from an acute overdose or from the accumulated lifetime dose. With increased life expectancy the lifetime UVR dose becomes an increasingly important consideration when offering advice and prescribing for patients.

Ultraviolet Radiation Related Ocular Risk Factor

It is now well established and widely accepted that UVR exposure is implicated in the development of skin cancer and there is increasing evidence that UVR exposure also plays a causative role in the development of a range of ocular diseases. For example, there is a very strong association between UVR and the development of climatic droplet keratopathy, pterygium, some types of cataract and probably pinguecula as well.(11) UVR has also been implicated in age related macular degeneration (AMD). UVR has been shown to induce a number of angiogenic factors, most notable vascular endothelial growth factor (VEGF) and strategies designed to block VEGF have shown considerable promise in the treatment of AMD. UVR exposure causes proliferative changes and may be involved in the development of ocular tumors such as uveal melanoma (12-18).

High doses of short wavelength blue light have been shown to be capable of damaging the retina (19). However, the evidence for that naturally occurring short wavelength blue or violet light as a risk factor in macular disease is inconclusive and devices filtering out this waveband appear to negatively affect contrast sensitivity and color perception (20,21).

Although UVR is far from the only cause of cataracts, it is a significant risk factor for certain types. The ozone layer has been predicted to continue to decline in thickness, by possibly 20%, and this depletion is predicted to increase the cortical cataract prevalence.(22) A modest increase in UVR carries with it an elevation in health care costs and, therefore, is a public health issue.(22)

The implications of corneal diseases such as keratoconus and pellucid marginal degeneration (PMD) and some refractive surgeries, all of which lead to thinning of the corneal stroma, should also be considered. Since much of UVB absorption takes place in

the corneal stroma, the thinning of the stroma that occurs in these conditions reduces its ability to filter out UVR, thus compromising its function in protecting intraocular structures, especially the crystalline lens (2).

As the human lens normally absorbs UVR, individuals who have undergone cataract surgery are at increased risk of UVR damage to the retinal tissue. Therefore these patients must receive UVR blocking intraocular lenses (IOLs) at the time of cataract surgery to prevent UVR-related damage. Where IOLs are contraindicated, UVR protection must be prescribed in the spectacle or contact lens correction for this group of patients (23,24).

Ultraviolet Radiation Related Ocular Protection

When the ocular media are intact and undamaged the cornea will filter out most of the UVB with the crystalline lens also filtering out most of the UVA. However, this still means the anterior surface of the lens is exposed to significant levels of solar UVR causing cataract formation and the anterior corneal surface is exposed to the full force of solar UVR. The ideal solution is to provide full UVR protection to the cornea and the related limbal and conjunctival stem cells thus preventing UVR related ocular damage to all ocular media and adjacent tissue where the epithelial stem cells are located. UVR-induced mutations within these stem cells are associated with pterygium formation, one of the most common ocular pathologies worldwide.

While UVR-blocking spectacles will provide adequate UVR protection from rays normally incident to the eye they may not block out ambient diffuse and surface reflected UVR because they are placed away from the eye leaving a gap through which UVR may

reach the ocular surface. UVR-blocking contact lenses, that extend over the limbus and palisades of Vogt, will provide complete protection allowing the user to remain safely outdoors for significantly longer periods because their UVR filtering capacity, although not total, brings UVR levels down to what is considered safe levels (3). There is a significant body of research suggesting that laterally incident UVR rays can be focussed across the cornea onto the nasal limbus where many UVR related ocular diseases such as pterygium occur (25,26). From a UVR protection perspective, this important fact makes the UVR blocking contact lens an important option for ocular protection versus a spectacle correction.

There is an urgent need to educate the public and ocular healthcare providers regarding the relative efficacy and insufficiency of their ocular media in protecting their eyes and how protection may be enhanced with UVR blocking eyewear, particularly contact lenses. In addition, the development and adoption of a scientifically based measure of a relative protection factor for eyewear that can easily be understood by the public and ocular healthcare providers and applied clinically, is recommended.

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