Blue Light and The Eye

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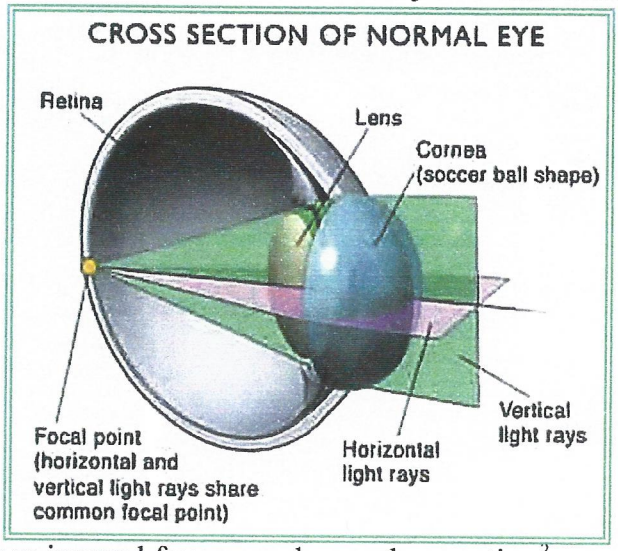
A growing concern for today's optometrists is the effect of high energy visible light on the visual system in general and the retina in particular. This paper will explore the theories surrounding the role of blue light in the development of macular degeneration. It will also discuss how this role relates to the routine use of blue light in Syntonic Phototherapy.

Studies have shown that blue light has photochemical and photoelectric effects on retinal tissue. These effects include free radical generation, oxidation, inflammation, and toxic bioelectric currents, especially in the macular area. To better understand these effects, it is necessary to consider some of the current theories surrounding macular degeneration pathophysiology. Most damage incurred from macular degeneration occurs as atrophy in the retinal pigment epithelium and choroid layers. It is within these layers that a cholesterol compound called lipofuscin is created. It coalesces into metabolic waste called drusen, a major marker of risk in macular degeneration.



Drusen have a direct optical resonance with light from 410 to 440nm. This light frequency can trigger photochemical reactions resulting in free radical oxygen species. These byproducts damage sensitive tissues in the retina and choroid.

The outer photoreceptor segments shed cells daily from light bleaching; these cells must be phagocytized by adjacent REP cells. This phagocytation involves a complex process of recycling photo pigment and polyunsaturated fatty acids. These compounds are very susceptible to free radicals and oxidation resulting in lipofuscion production and damage to mitochondria in the outer rod cell segments.[1]

The drusen, an accumulation of these reactions, begins to fill the sub-retinal spaces, blocking fluid and enzymes to Bruch's membrane and the macular area. This disrupts normal metabolism triggering apoptosis or cell death.

A molecule in the drusen called A2E is the key inflammatory and oxidation compound that destroys adjacent cells. A2E has a maximum photonic resonance to light at 440nm; this creates oxidative stress on the RPE and outer rod cells that surround the macula.

There is also an abundance of oxygen in the macular area where venous blood contains 90% oxygen. The reservoir of oxygen adds to the quantity of free radicals that will attach to local tissues in the area . The presence of drusen serves to provide additional free radicals. Drusen are considered a hallmark of aging and are a risk for both wet and dry macular degeneration.[2]

Blue light seems to be 50 to 80% more damaging to the macular area than green light. The macular area is more exposed to light because it is an outer retinal layer. It is protected in several ways.

The cornea filters ultraviolet at 295nm, the lens absorbs UVB from 280 to 303nm, and UVA from 315 to 400nm. This effectively reduces light below 540nm by 70 to 80%. As the lens ages, it becomes progressively more yellow, filtering out more and more blue light.

The macula itself has three carotenoids, lutein, zeanthin, and meso-zeaxanthin, which absorb blue light and make up the protective macular pigment. These pigments serve as powerful antioxidants and their deficiency leaves the macula more vulnerable.. New technologies such as the MacuScope can measure their presence and serve as a guide to supplement one's diet as necessary.[3]

Supplementing patients who have age-related macular degeneration (AMD) with melatonin has shown to prevent, reduce, and reverse both wet and dry macular degeneration.

Melatonin has been shown to play a role in regulating both retinal pigment and photoreceptor pathway signaling. Melatonin has also been shown to dissolve drusen. Melatonin's protective factors are reduced when enzymes, essential to its production, are depleted by stress hormones.[4] (Melitonin is primarily produced by the pineal gland, where production is most powerfully suppressed by blue light. However, it is also produced in the retina because of the retina's lack of storage capability.)
The retinal protein melanopsin is another photosensitive substance found in the ganglion cell layer. It has a peak spectral sensitivity to short wavelength blue light. Melanopsin stimulation contributes to regulation of the following: circadian rhythm synchronization, , visual and auditory attention enhancement, EEG activity, cortical enhancement of cognition and alertness, and pineal gland function. [5] Blue light stimulation of melanopsin coordinates with melatonin production in our circadian rhythm regulation and possibly in retinal hormone production and physiology.

Light sensitive hormones certainly seem to be an important part of visual and non-visual function and health. A new theory proposes that hormone deficiencies play an integral role in macular degeneration.

It is theorized that the retina and macula accumulate cholesterol in an attempt to synthesize hormones such as pregnenolone from DHEA(a natural steroid produced by the adrenal glands).Pregnenolone, along with certain enzymes, can protect the macula from both vascular and neurological damage. Deficiencies of pregnenolone may also lead to the production of pathological drusen and subsequent AMD.

Patients with AMD tend to have low blood hormone levels of DHEA as well as a higher risk of cardiovascular mortality. Dr.'s George Rozakis and Sergey Dzugan have proposed a hormonal theory of macular degeneration. A major study is underway to determine if restoring optimal hormone balance by supplementation can prevent or reverse the progression of AMD.[6]

In Syntonic phototherapy, the stimulation of the adrenocortical, ovarian, and testicular hormones is facilitated by giving both alpha-omega (ruby) and mu-delta (yellow green)frequencies. Blue light may depress these hormonal actions.[7] The use of colored light stimulation to balance the endocrine system can play an important therapeutic role in treating AMD.

Evidence, therefore, supports that blue light may cause local retinal tissue damage from ionization, oxidation, free radical production, and systemic harm from endocrine imbalances. The sources of blue light we need to be concerned about surround us in modern society.

Fluorescent lighting uses high temperature mercury which puts out a spectral peak of narrow band blue light in the 440nm range. This narrow band emission is also found in screw-type high efficiency bulbs, and CRT and LCD computer monitors. Dr. Alexander Wunsch, a German physician, has done extensive research in the physics and biological effects of the this narrow band lighting on human health. He has found that blue light is chrono-biologically active. This activity can cause sleep disorders, oxidative stress, mitochondrial damage , increased stress hormones such as ACTH, and reduced melatonin associated with macular protection.

Dr. Wunsch also points out that due to chromatic aberration, blue light focuses optically in front of the retina creating a blur. . This area of retinal defocus contributes to visual and nervous stress.[8] LED light sources are also narrow band light sources that may be hazardous with direct illumination in the eyes. Research indicates that the risk increases with higher levels of radiance and exposure. Safety standards are lacking at this time for this risk.[9]

What can we do as practitioners to council our patients and reassure them that our treatment with blue light is safe? First of all, we generally use blue light in tandem with green, which is outside the spectral area of concern. In treatment, we use blue combined with indigo which has a wide spectral range from 500 to 680nm. We can recommend blue-blocking yellow tints for those who work long hours on a computer.

We can also recommend using incandescent lighting in the computer workplace and advise against the use of high energy screw-in bulbs. These bulbs pose health concerns and disposal problems due to the mercury inside them. Environmental lighting protocols advocate the use incandescent lighting as much as possible because they emit in the infrared region of the spectrum.

It is recommended that our AMD patients supplement their diet with antioxidants, including: vitamins A, C, E,

alpha-carotene, beta-carotene and the yellow carotenoids, lutein, zeanthin and meso-zeaanthin. (whose yellow pigment absorb blue light).

Recent research has found that infrared light possesses a regenerative potential for tissue repair. Infrared serves to repair mitochondria and regenerate cell metabolism damaged from blue light. In addition, infrared reduces reactive oxygen species created by blue light.

Many biological indicators point to a reduction of cell death by exposure to infrared light. [10] This may mean that color therapy instruments that have infrared radiation will compensate for any blue or high energy wavelength risks. These healing effects indicate a tremendous potential for the use of longer wavelength filters in the treatment of retinal disease. We have begun to use red and yellow-green more in the treatment protocols with our AMD patients.

Blue light has many healing properties and has been used therapeutically since recorded time. From all the available literature, blue light can and does cause damage. In Syntonics, we use blue light in a limited mixture and augment the filters with infrared from our instrument light sources.

Syntonics helps balance the endocrine system and, therefore, plays a role in retinal protection. Therapeutic application of blue light possesses no risk to our patients. We know sunlight is very healing but overexposure can cause melanomas. We must educate ourselves and our patients that excessive exposure to narrow bands in the blue range of the spectrum should be avoided

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