BLUE LIGHT AND THE RETINA: GOOD AND BAD?

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Objectives: In the context of light treatment modalities, blue light exposure is Janus-faced: the action spectrum of inherently light sensitive retinal ganglion cells that are thought to mediate circadian light signals to SCN/LGN lies within the blue part of the spectrum (λ_{max} 470-480 nm). Use of blue light exposure might thus result in high therapeutic efficacy and efficiency, although this has not been proven. On the other hand, blue light is known for its high damage potential in the vertebrate retina. The aim of this overview is to demonstrate blue light-induced retinal lesions and to outline our search for the damaging molecule(s). **Methods:** Anesthetized pigmented and albino mice were exposed to green (550±10 nm) or blue (408±10 nm and 430±10 nm) for different durations, and photoreversal of the rod visual pigment rhodopsin, retinal morphology, apoptotic death of photoreceptors and the pro-apoptotic transcription factor AP1 (activator protein 1) were analyzed. Additionally, mice deficient in phototransduction or in termination of rhodopsin activation were exposed to green or blue light. **Results:** Exposure to 408 or 430 nm light induced massive lesions in the retina proportional to exposure duration. 1-2 min of 408 nm and 25 minutes of 430 nm are sufficient to cause irreversible death of photoreceptors and lesions of the retinal pigment epithelium. By contrast, exposure to green light, even of extended duration, does not induce structural changes. 96% bleaching of rhodopsin by green light, followed by exposure to blue, results in 30% recovery of rhodopsin. Notably, in contrast to white light exposure, blue light-induced apoptosis is independent of AP1, and is not prevented by dexamethasone. Furthermore, phototransduction and rhodopsin inactivation do not seem to contribute to blue light lesions. Preliminary data show that green followed by blue may rapidly create a damaging molecule(s) whose characteristics are as yet unknown. **Conclusion:** We recommend extreme caution to use blue light in the spectral range of 420 nm for light therapy. The action spectrum of light-sensitive retinal ganglion cells was found to peak at 470-480 nm, a range with lower damage potential, yet not completely outside the damaging range. Furthermore, the transmission of the human (and animal) ocular lens shows markedly reduced short-wavelength blue light transmission with increasing age; therefore, 420 nm would reach the retina only in young eyes, and only at distinctly lower dose in older individuals. The potential therapeutic efficacy of blue light would be reduced in persons about 50 years of age and older, and young eyes would be particularly vulnerable to blue light-induced lesions.

Keywords: Retina, Light damage, Apoptosis, Blue light, Green light

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