Transmission Spectrum of Intraocular Lenses by Ultraviolet Light Exposure

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Abstract: The transmission spectrum of five types of intraocular lenses (IOLs) was measured to assess visual performance after cataract surgery. A UV-Visible spectrometer was used to measure the transmission spectrum of IOLs after exposure to UV light with varying power and exposure time. For Samples (a) and (b), the transmittance is almost zero from 200 nm to 400 nm; the transmittance also decays in the visible region. For Samples (c) and (d), the IOLs cannot block the wavelength from 200 nm to 300 nm. For Sample (e), the IOL cannot block the wavelength from 200 nm to 400 nm. The transmittance of IOLs decays with increasing UV power and exposure duration.

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1. Introduction

A cataract is one of the most serious blinding diseases in the world. Cataracts have become the leading cause of reversible loss of useful vision resulting in decreased contrast sensitivity [1, 2] and increased visual disability because of glare [3, 4]. Cataract surgery is usually combined with the implantation of an intraocular lens (IOL). UV light-filtering lenses play a key role in cataract surgery. Evidence shows that UV light causes cystoid macular edema and photic retinopathy. The absorption spectrum of IOLs is very important because UV light-filtering IOLs do not protect the retina from phototoxic damage by high-energy short-wavelength light. The crystalline lens gradually becomes yellow with age, thus reducing the transmission of blue light and preventing it from reaching the retina [5-14].

UV transmitting and UV-blocking IOLs are used widely today. UV-transmitting IOLs do not have chromophores. Colorless UV-blocking IOL chromophores absorb most UV radiation and possibly some violet light. The colors of IOLs are important because it affects the transmission spectrum. In this study, we measured the transmission spectrum of IOLs to assess visual performance after cataract surgery.

2. Experimental

Sample Preparation

Figure 1 shows the five types of IOLs. The samples are denoted as (a), (b), (c), (d), and (e).

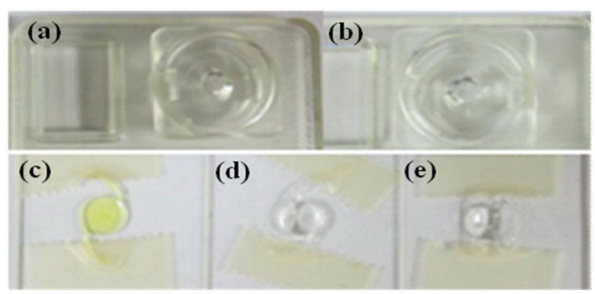

Figure 1: Five types of IOLs.

Setup

Figure 2 shows the experimental setup for the transmission spectrum measurement of IOLs. Non-polarized UV light was expanded and passed through a neutral density filter (NDF), which can adjust the intensity of UV light. A photodiode was linked to a computer to measure UV intensity. A UV-Visible spectrometer was used for measuring the transmission spectrum of IOLs after UV light exposure.

Procedures

(1) Exposure time was fixed at 1 min, and UV power was set to 0, 1, 5, 25, and 50 mW. The transmission spectrum of IOLs was measured from 200 nm to 1000 nm.

(2) Exposure time was changed from 1 min to 180 min, and UV power was changed to 0, 1, 5, 25, and 50 mW. A transmission intensity of 565 nm was observed.

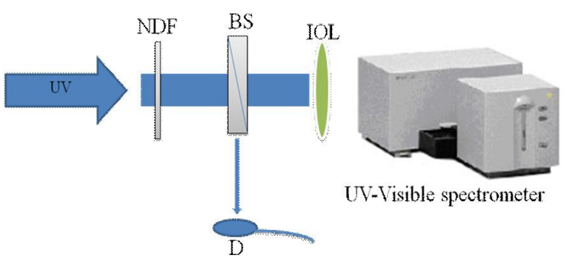

Figure 2: Experimental setup for the transmission spectrum measurement of IOLs. (Neutral density filter [NDF]; beam splitter [BS]; detector [D])

3. Results and Discussions

Figures 3(a) to 3(e) show the variations of the transmission spectrum for Samples (a) to (e). The transmittance approaches zero from 200 nm to 400 nm for Samples (a) and (b). The transmittance gradually decays with increasing UV power for Sample (a), and obviously decays when UV power is higher than 50 mW for Sample (b). For Samples (c), (d), and (e), the transmittance from 200 nm to 300 nm is relatively large. For Samples (c) and (d), the transmittance from 300 nm to 400 nm are almost zero; for Sample (e) the transmittance is nonzero. The transmittance decays rapidly under low UV exposure for Sample (c), decays when UV power is higher than 5 mW for Sample (d), and gradually decreases with increasing UV power for Sample (e).

Figures 4(a) to 4(e) show the variations of the transmission intensities at a wavelength of 565 nm with varying UV power and exposure time. The transmittance slightly decreases with increasing UV power (UV power is less than 50 mW). The transmittance rapidly decreases with a UV power of ~50 mW under an exposure time of ~50 min for Sample (a). When the exposure time is longer than 60 min, the transmittance is maintained at a stable level. For Sample (b), the transmittance gradually decreases with increasing UV power and exhibits a stable signal when UV exposure is longer than 60 min. For Sample (c), the transmittance rapidly decays if UV power is higher than 5 mW; the transmittance decays if UV power is higher than 5 mW. For Sample (e), the transmittance decays if UV power is higher than 25 mW.

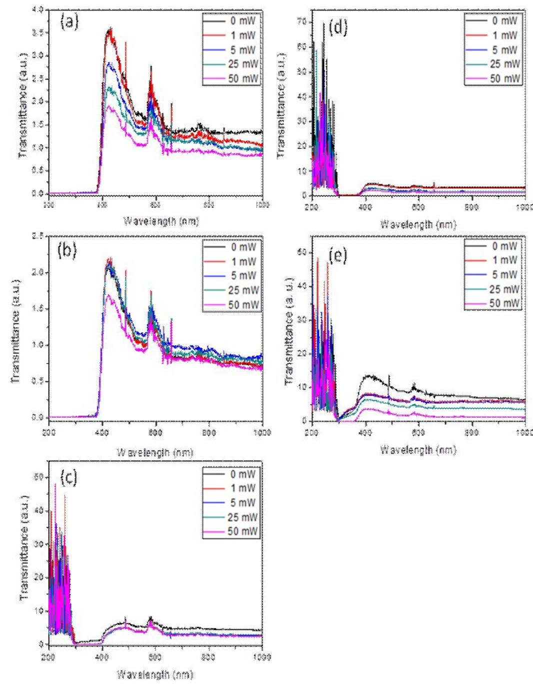

Figure 3: Variations of transmission spectrum corresponding to samples (a) to (e).

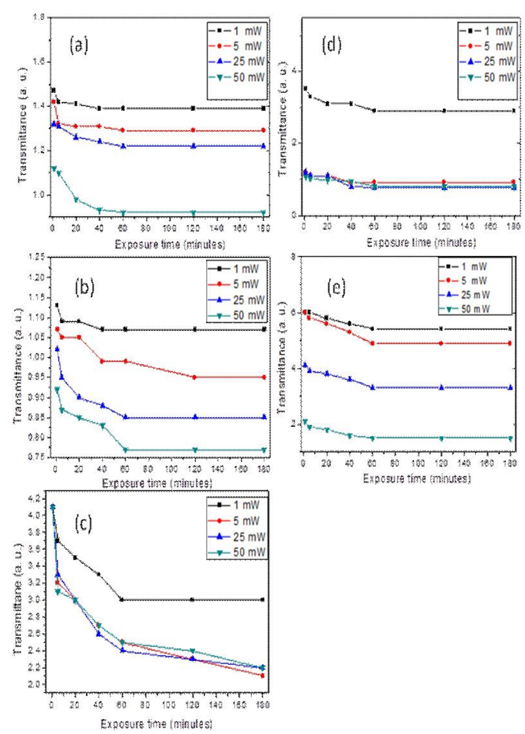

Figure 4: Variations of transmission intensities at a wavelength of 565 nm under different UV power and exposure time.

4. Conclusion

We measured the transmission spectrum of five types of IOLs. For Samples (a) and (b), the transmittance approaches to almost zero from 200 nm to 400 nm and decays in the visible region. For Samples (c) and (d), the IOLs cannot block the wavelength from 200 nm to 300 nm. For Sample (e), the IOLs cannot block the wavelength from 200 nm to 400 nm. The transmittance of IOLs decays with increasing UV power and exposure duration.

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