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Light Transmission through UV Coated Contact Lenses

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ABSTRAK

Tujuan kajian ini adalah untuk menentukan keberkesanan monomer penyerap sinar ultralembayung (UL) dalam kanta sentuh untuk melindungi mata dari sinar UL. Transmisi spekra 8 jenis kanta sentuh (7 kanta sentuh lembut iaitu Precision UV, Acuvue 2, Surevue, Omega, Encore UV, Durasoft 3 dan Lunelle UV dan 1 kanta sentuh separa keras, Boston 7) dinilai dengan menggunakan spektrofotometer sinar berkembar. Kanta Durasoft 3 (tanpa monomer penyerap UL) bertindak sebagai kawalan. Keputusan kajian menunjukkan kanta sentuh Precision UV mampu menyerap sinar UL sehingga jarak gelombang 380 nm. Kanta sentuh Acuvue 2 and Surevue pula menyerap sinar UL sehingga 360 nm sahaja. Kanta sentuh Omega, Encore UV and Lunelle UV boleh menyerap sinar UL hanya sehingga 335 nm dengan nilai transmisi spektra yang paling tinggi untuk kanta Lunelle UV iaitu sebanyak 17%. Kanta sentuh separa keras Boston 7 pula mampu menyerap sinar UL sehingga 385 nm. Walau bagaimanapun, peratusan sinar UL yang menembusi kanta ini adalah lebih tinggi dari kanta sentuh lembut, iaitu sebanyak 30%. Kanta sentuh Durasoft 3 pula mampu menahan sinar UL pada jarak gelombang 200-245 nm sahaja. Kanta sentuh Precision UV mempunyai ciri perlindungan dari sinar UL terbaik berbanding kanta sentuh lain yang diuji. Kanta sentuh lembut dengan monomer perlindungan sinar UL merupakan alternatif untuk perlindungan struktur internal mata dari sinar UL.

Kata kunci: transmisi cahaya, monomer penyerap UV, perlindungan ultralembayung, kanta sentuh, transmisi spekra

ABSTRACT

The objective of this study was to determine the efficiency of UV blocking monomers in contact lenses in providing eye protection from UV radiation. The spectral transmission of 8 contact lenses (7 soft contact lenses: Precision UV, Acuvue 2, Surevue, Omega, Encore UV, Durasoft 3 and Lunelle UV and 1 rigid gas permeable contact lens: Boston 7) was evaluated by using a dual beam spectrophotometer. Durasoft 3, a non UV absorbent contact lens was used as the control. The results showed that Precision UV contact lens absorbed UV light up to wavelength of 380 nm, whereas Acuvue 2 and Surevue absorbed up *to 360 nm only. Omega, Encore UV and Lunelle UV lenses absorbed UV light up to 335 nm with spectral transmission of Lunelle UV being the highest among all soft contact lenses tested, which was 17%. Boston 7 could absorb UV light up to 385 nm, but the amount of UV light transmitted was higher than soft lenses, which was 30%. Durasoft 3 only blocked UV light at 200-245 nm. Precision UV lens had better UV blocker characteristics than the other contact lenses tested. UV blocking soft contact lenses could be an alternative for spectacles in protecting internal ocular structures from UV radiation.*

Keywords: light transmission, UV blocking monomers, ultraviolet protection, contact lens, spectral transmission

INTRODUCTION

The need of ultraviolet (UV) protection in the natural environment has become a popular topic in the media. The depleting ozone layer and the growing ozone hole in the Antarctic have contributed to the debate. This has led manufacturers to produce UV absorbing sunglasses with claims of 95% or 100% UV protection. The adverse effects of UV radiation on ocular tissues are well documented. Cataracts, pinguecula, pterygium, photokeratitis, age related macular degeneration are believed to be caused by excessive exposure to UV radiation (West et al. 1998). Lifetime exposure to UV radiation can also cause premature presbyopia, encountered in populations more exposed to solar irradiance (Sliney 2001). Protection of the eye from the UV light is necessary for everyone especially for aphakic or pseudophakic patients and people who are exposed to high UV radiation everyday such as welders, mechanics and electricians.

According to the International Committee on Illumination (CIE), the UV spectrum is divided into three bands: UVA (315 to 380 nm), UVB (290 to 315 nm) and UVC (200 to 290 nm). Each UV band has been shown to be absorbed differently by the ocular tissues. UVA is preferentially absorbed by cornea and retina. UVB is mainly absorbed by crystalline lens and partially by retina. UVC is filtered out by the ozone layer in the atmosphere, so that only UVA and 10% of UVB are transmitted through the atmosphere and reach the earth (Pitts 1990; Young 1994). One of the ways suggested to protect the eye from UV radiation is by using UV absorbent contact lenses. Such contact lenses have UV absorbent monomers that can protect the cornea and the internal part of the eye from UV damage. Earlier studies have shown that contact lens with ultraviolet absorbing monomers reduce UV transmittance which means protection to the cornea and internal structures of the eye (Walsh et al. 2003; Harris et al. 2000; Hickson-Curran et al. 1997). The reported UV protection levels from a number of studies of various UV absorbing contact lens show transmittance spectra that are either consistent with or better than protection offered by lenses without UV absorber (Walsh et al. 2003; Quesnel et al. 2001). Furthermore, soft contact lenses offer limbal coverage that could yield increased protection of the internal structures of the eye from obliquely incident UV rays that are not blocked by spectacle lenses (Kwok et al. 2003).

As the depletion of the ozone layer continues, it is predicted that there will be an increase in the amount of short wavelengths UV light reaching the earth's surface, and consequently, an increase in health problems (Rozema et al. 2002; Longstreth et al. 1998). Together with the amount of time spent outdoors as well as rising popularity of disposable mode of soft contact lens wear; UV protection could be a significant consideration when fitting soft contact lenses. Previous studies evaluating the efficacy of UV absorbing soft contact lenses in reducing UV transmittance have found attenuation ranging from 1 to 99%, depending on lens types (Walsh et al. 2003; Harris et al. 2000; Quesnel & Simonet 1995). Walsh et al. (2003) mathematically analyzed UV-blocking capabilities of several soft contact lenses available in the US market. Their analysis indicates that UV-blocking soft contact lenses reduce UV radiation that enters the eye to safe levels. The greatest reduction was offered by Precision UV lens, then Acuvue 2, Surevue and Biomedics 55 UV.

Harris et al. (2000) measured the spectral transmittance of several Vistakon's disposable soft contact lenses (1 Day Acuvue, Acuvue, Surevue and Vistavue) using dual beam spectrophotometer. Their results indicate that lenses that incorporate UV blocking monomer significantly reduced the transmission of UV radiation while untreated lenses did not. Their findings also indicated that Surevue and Acuvue lenses met the requirement of American National Standards Institution (ANSI) for Class 2 UV blockers. Quesnel and Simonet (1995) studied the light transmission spectra of 8 different brands of UV absorbent contact lenses and proposed a calculation of protective factor for each of the lenses tested:

$$\text{Protective factor} = 100/T$$

Their results showed that Fluoroperm 30, Fluoroperm 60 and Fluoroperm 92 contact lenses provided the highest UV protection with protection factor of 1000. These contact lenses allowed only 0.1% of light transmission in the UV range.

The purpose of this study was to evaluate the spectral transmission of several UV absorbent contact lenses that were available at the Optometry Clinic, Universiti Kebangsaan Malaysia (KOUKM), Jalan Raja Muda Abdul Aziz, Kuala Lumpur.

MATERIALS AND METHODS

Seven different brands of soft contact lenses (Precision UV, Acuvue 2, Surevue, Omega, Encore UV, Durasoft 3 and Lunelle UV) Boston 7) and one rigid gas permeable lens (Boston 7) that were available at KOUKM were evaluated in this study. *Durasoft 3* (without UV absorbent characteristics) acted as the control. The parameters of the contact lenses used are listed in Table 1. Light transmission measurements were conducted using the dual beam spectrophotometer (model UV 160A, Shimadzu, Japan). Each contact lens was placed in a saline filled quartz cell before placing it inside the spectrophotometer. The second quartz cell was filled with saline only. The transmission spectrum was taken from 200 nm to 800 nm. The light transmission was taken three times for each lenses and the mean and standard deviations were calculated. Each contact lens was placed inside the cell with the convex side facing the light source and the saline was replaced each time a new contact lens was tested.

TABLE 1. Parameters of the contact lenses tested

Contact lens	Material	Colour	Base curve (mm)	Power (D)	Diameter	Central Thickness (mm)
Precision UV	Vasurfilcon A	nil	8.7	-1.25	14.4	0.15
Igel Omega	38UV	nil	8.6	-3.00	14.0	0.16
Encore UV	Hema (Filcon 1A)	nil	8.6	-3.00	14.0	0.15
Lunelle UV	Hema	nil	8.6	-3.00	14.0	0.15
Surevue 2	Etafilcon A	Visiblity tint	8.8	-1.25	14.0	0.17
Acuvue 2	Etafilcon A	Visiblity tint	8.7	-3.25	14.0	0.10
Durasoft 3	Phemfilcon A	Blue	8.6	plano	13.2	0.14
Boston 7	Satafocon A	nil	8.0	-3.00	9.3	0.16

RESULTS

The results showed that all contact lenses tested allowed more than 90% of light transmission at wavelengths between 400-800 nm. The percentage of light transmission approached 100% at 800 nm. At 240 nm, Omega, Encore UV, Acuvue 2, Surevue and Precision UV allowed between 0.91-3.92% of light transmission. Percentage of light transmission through Lunelle UV contact lens is higher (7.55 ± 0.01%) than other contact lenses tested at the same wavelength. The percentage of light transmission through Surevue and Precision UV lenses at 240 nm was 3.92 ± 0.02% and 3.0 ± 0.01%, respectively.

Acuvue 2 lens provides better UV protection than other lenses tested at 300 nm. Acuvue 2 allowed only 2.83 ± 0.03% of light transmission while *Encore UV* and Omega allowed 4.22 ± 0.01% and 4.72 ± 0.01% respectively. The percentages of light transmission for Precision UV and Surevue at similar wavelength were equal (4.63 ± 0.02%) while Lunelle UV allowed the highest percentage of light transmission through it, which were 13.00 ± 0.01%.

At 360 nm, Surevue and Precision UV give the lowest light transmission than other lenses tested. The amount of light transmission was 9.01 ± 0.01% and 8.92 ± 0.02% respectively. Percentage of light transmission for Acuvue 2 lens was lower (11.51 ± 0.01%) than Omega (46.51 ± 0.02%) and Encore *UV* (46.61 ± 0.01%) at similar wavelength. Lunelle UV provides the least UV protection at 360 nm with 53.91 ± 0.01% of light transmission. Durasoft 3 only blocks UV light at 200 to 245 nm and allow almost 80% of light transmission at wavelength of 280 nm onwards. Detailed results are shown in Figures 1 and 2.

Light transmission pattern using rigid gas permeable lens (Boston 7) differed from the soft contact lenses (Figure 3). Percentage of light transmission was almost consistent at all UV wavelengths tested. At 240 nm, percentage of light transmission through Boston 7 lens was 27.93 ± 0.01%, at 300 nm was 30.44 ± 0.02% and at 360 nm was 31.62 ± 0.01%. At 400 nm, its light transmission had increased to 76.23 ± 0.02% and approaching to almost 100% at 800 nm.

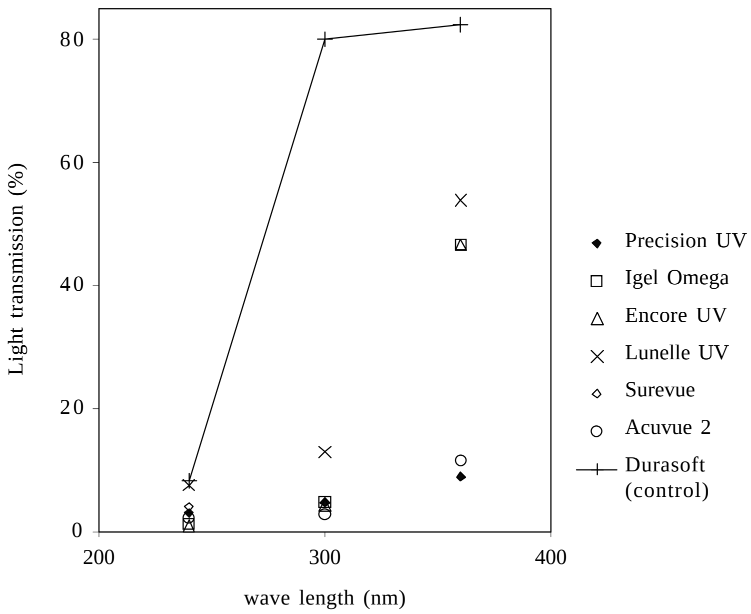

FIGURE 1. Percentage of light transmission vs. wavelength (240-360 nm) for seven different brands of soft contact lenses.

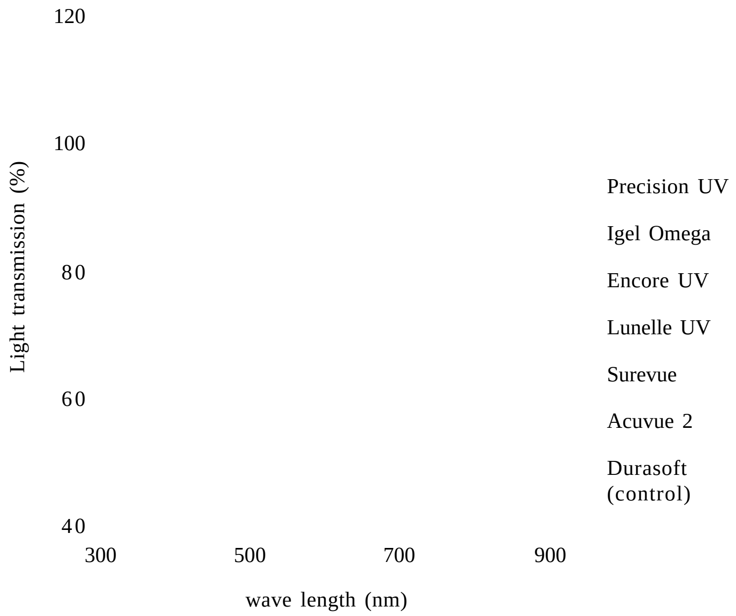

FIGURE 2. Percentage of light transmission vs. wavelength (400-800 nm) for six different brands of contact lenses.

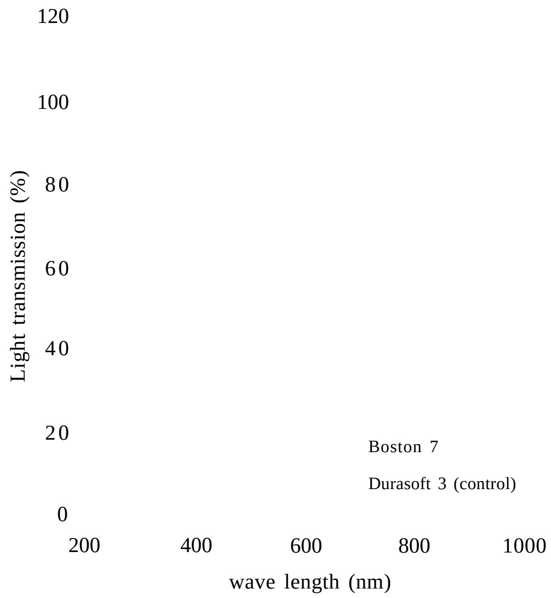

FIGURE 3. Percentage of light transmission for rigid gas permeable contact lens (Boston 7) when compared to control (Durasoft 3)

DISCUSSION

Every contact lens has its own transmittance characteristics and the results from this study supported the statement (Kwok et al. 2003; Harris et al. 2000). The transmission pattern varies at shorter wavelengths (200-400 nm) but similar at longer ones (450-850 nm). This is possibly due to different material and integral component used to block UV radiation (Quesnel & Simonet 1995; Dain & Pye 1993). Besides that, every contact lens has its own refractive index, internal structure and design that contribute to refraction and reflection of light and cause variation in light transmission pattern (Giasson et al. 2005; Faubl & Quinn 1998).

Our results indicated that all contact lens tested provide some ocular protection against UVA, UVB and UVC. Acuvue 2 provide best protection against UVB while Surevue and Precision UV provide highest protection against UVA. These lenses meet the American National Standards Institution (ANSI) Standard Z80.20 Class 2 UV blockers: a maximum of 30% transmittance of UVA wavelengths and 5% transmittance of UVB wavelengths (Harris et al. 2000). The UVA and UVB transmittance values found for Acuvue and Surevue lenses correspond well with values found by Harris et al. (2000) and Hickson-Curran et al. (1997).

Our results at 240 nm (UVC) showed transmission between 1-8%. Currently UVC transmittance is not considered as ocular health concern as only small amounts of radiation in the UVC range reach the earth's surface due to filtering effects of the ozone layer (Bergmanson & Sheldson 1998). Depletion of the ozone layer is actually thought to increase the transmittance of wavelengths in the UVA and UVB ranges (Giasson et al. 2005).

The results from this study also showed that central thickness of the contact lenses tested did not have any effects on the transmittance spectra. The central thickness of Lunelle UV lens was 0.15 mm, but it allowed higher transmission of UV radiation than Surevue and Acuvue 2 with central thickness of 0.17 mm and 0.10 mm, respectively (Fig. 1 and 2). This is possible as contact lens transmittance is less dependent on thickness in the visible band compared with the strongly absorbing UV band where small changes in sample thickness of materials will exert a massive effect on transmittance (Giasson et al. 2005).

CONCLUSION

This study suggested that contact lens wearers working or spending significant time outdoors use UV blocking contact lens to reduce ocular dose of UV radiation and reduce the probability of developing UV associated ocular disease. UV coated soft contact lenses are effective and highly recommended to protect the internal structure of the eye. However, the external structures of the eye such as the conjunctiva and eyelids remain at risk and would continue to benefit from the use of UV blocking sunglasses.

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