The effect of ionizing radiation on the UV-blue light protection filter of Intraocular lenses

Ellas Spyratou[1], George Kareliotis[2], John Antonakos[1], Kalliopi Platoni[1], Constantinos Bacharis[2], Mersini Makropoulou[2], Alexander Serafetinides[2] and Efstathios Efstathopoulos[1]

1. Second Department of Radiology, Medical School, University of Athens, 11517 Athens, Greece

2. Physics Department, Faculty of Applied Mathematical and Physical Sciences, National Technical University of Athens, Zografou Campus, 15780 Athens, Greece.

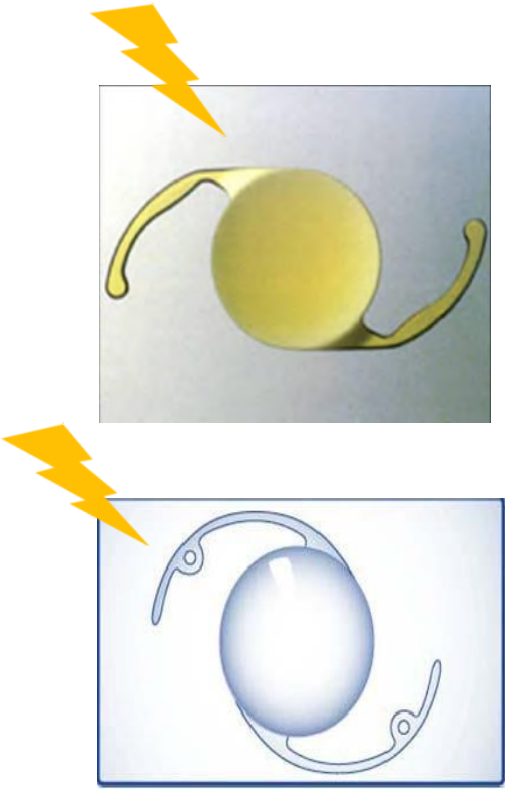
23rd ESCRS Winter Meeting
ATHENS
In conjunction with the 33rd HSIOIRS International Congress

United Nations Educational, Scientific and Cultural Organization
International Year of Light 2015

The effect of ionizing radiation on the UV-blue light protection filter of Intraocular lenses

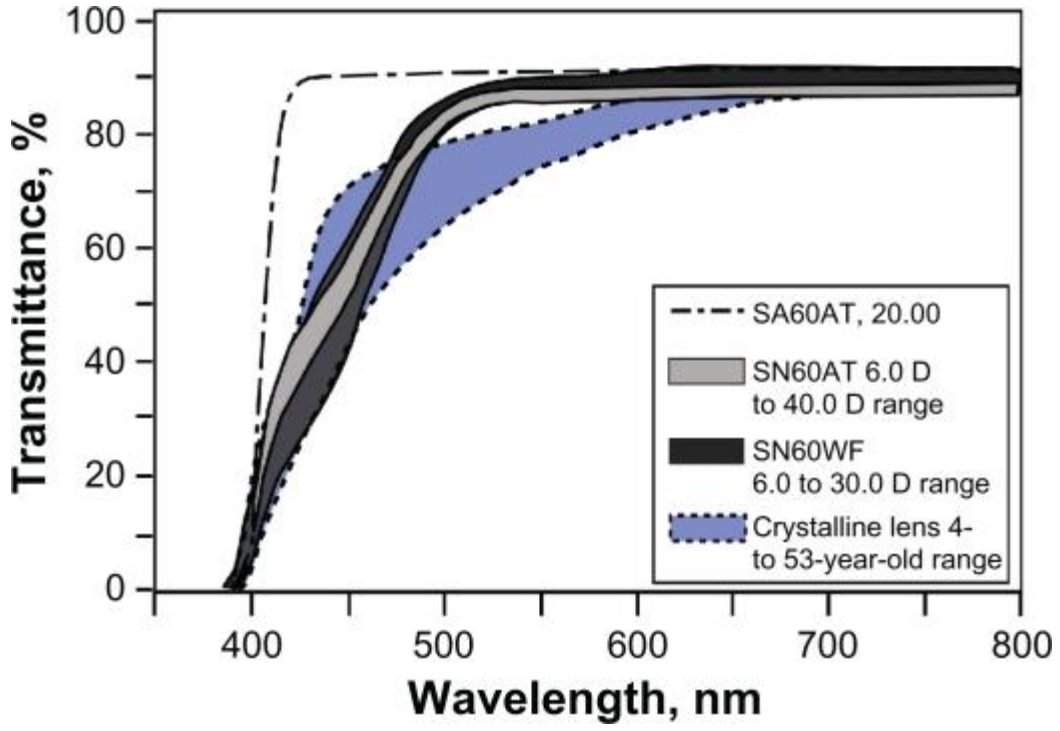
Purpose:

- The aim of this work was to examine the influence of ionizing radiation on the optical properties of the intraocular lenses (IOLs).
- The factors that affect the postoperative "life" of the IOL causing cloudiness or discoloration have no be yet fully clarified.
- As the implantation of IOLs increased extremely in our days, with a tendency to enter also in other ophthalmology disorders, the monitoring of eye exposures to ionizing radiation between patients, physicians and radiation workers, which have IOL implants, has become of increased interest.
- The results of the IOLs exposure to X-rays at clinical doses through diagnostic and therapeutic procedures are investigated.



The effect of ionizing radiation on the UV-blue light protection filter of Intraocular lenses

Transmission spectra of the natural crystalline lens and of the intraocular lens models



Yellow-azo dyes doped IOL blocks the UV and blue-light radiation and protect retina against harmful UV and short wavelength blue light.

Clin Ophthalmol. 2010; 4: 1465–1473.

The effect of ionizing radiation on the UV-blue light protection filter of Intraocular lenses

Methods:

- 3 Yellow azo-dye IOLs made from an acrylate/methacrylate copolymer were irradiated with x-rays at clinical doses. The X–rays irradiation was performed at ATTIKON hospital Radiotherapy department.

- 1 Undoped hydrophobic acrylic IOL made from acrylate/ methacrylate copolymer were used as control.

- The transmittance of the IOLs was measured pre-irradiation and post-irradiation by using a spectralon-coated integration sphere and a UV/Visible spectrometer. The light sources was a xenon lamp operating in 220-750 nm and a Halogen lamp operating in 360-2400 nm.

The effect of ionizing radiation on the UV-blue light protection filter of Intraocular lenses

Methods:

- The transmittance of the IOLs was measured pre-irradiation and post-irradiation by using a spectralon-coated integration sphere and a UV/Visible spectrometer. The light sources was a xenon lamp operating in 220-750 nm and a Halogen lamp operating in 360-2400 nm.

- The transmittance $T(\lambda)$ was precisely calculated according to the following relationship:

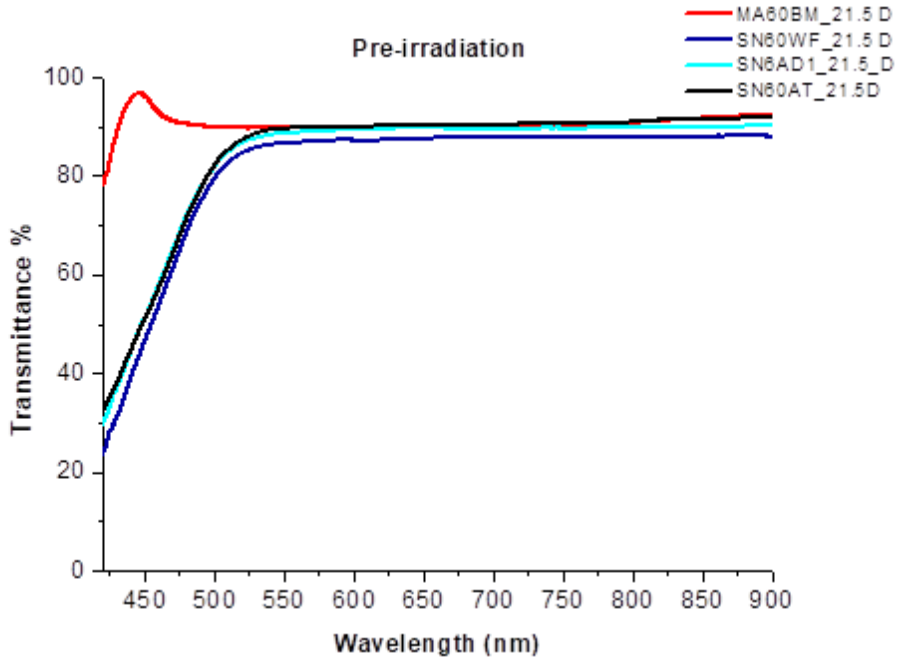
$$T(\lambda) = \frac{I_{s(\lambda)} - I_{D(\lambda)}}{I_{o(\lambda)} - I_{D(\lambda)}} \times 100\%$$

$I_{o\,(\lambda)}$: The reference light intensity.
$I_{D\,(\lambda)}$: The dark intensity.
$I_{s\,(\lambda)}$: The light intensity passing through the IOL.

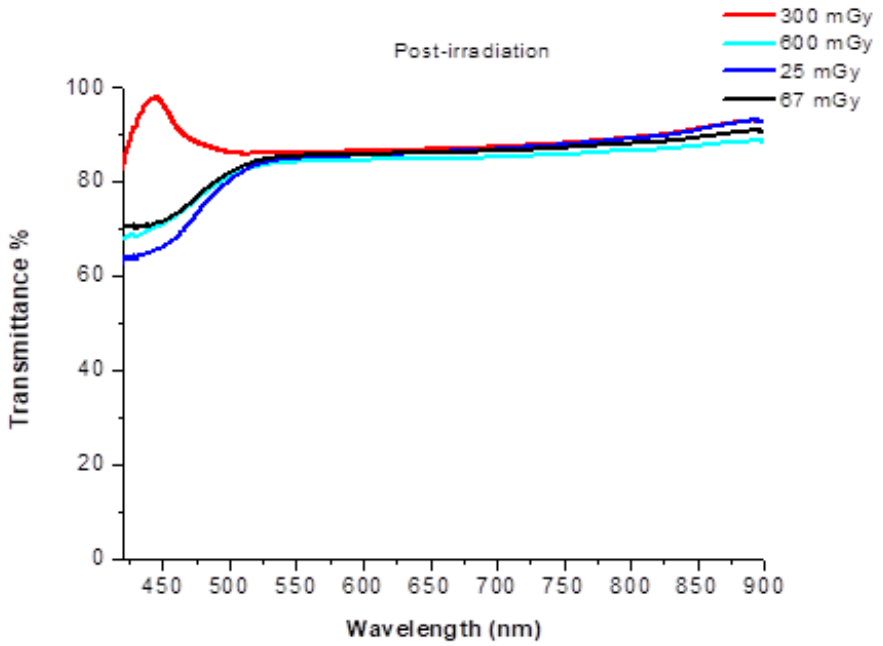
IOL Type	Radiation dose (mGy)
SN60AT_15.5 D	0.5
SN60T5_26.5 D	1.5
SN60WF_23.0 D	16
SN60WF_21.5D	25
SA60AT_26.0 D	60
SN6AD1_21.5D	67
MA60BM_21.5 D	300
SN60AT_21.5 D	600

The effect of ionizing radiation on the UV-blue light protection filter of Intraocular lenses

Results: X-ray irradiation of IOL with x-ray at clinical doses used in interventional radiology and cardiology procedures



Pre-irradiation total transmittance spectra of intraocular lenses in the visible region at 420-900 nm.

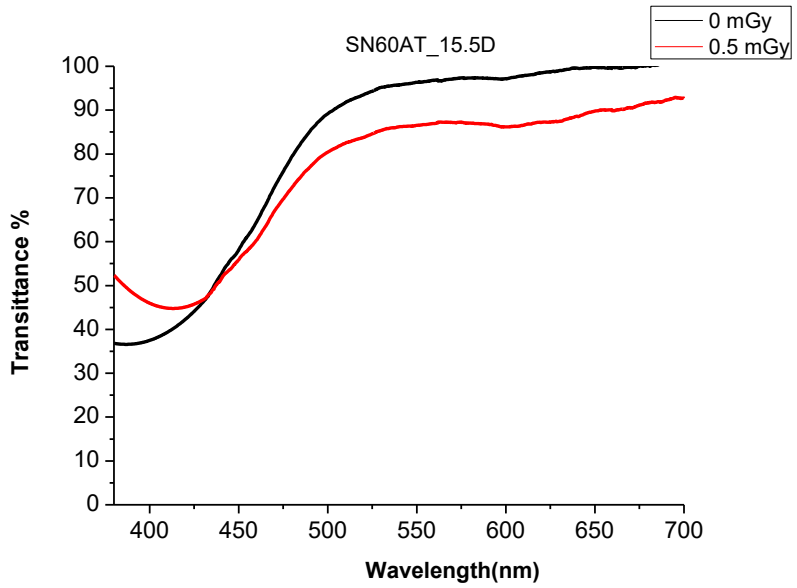


Post-irradiation transmission spectra of intraocular lenses in the wavelength region from 420 nm to 900 nm.

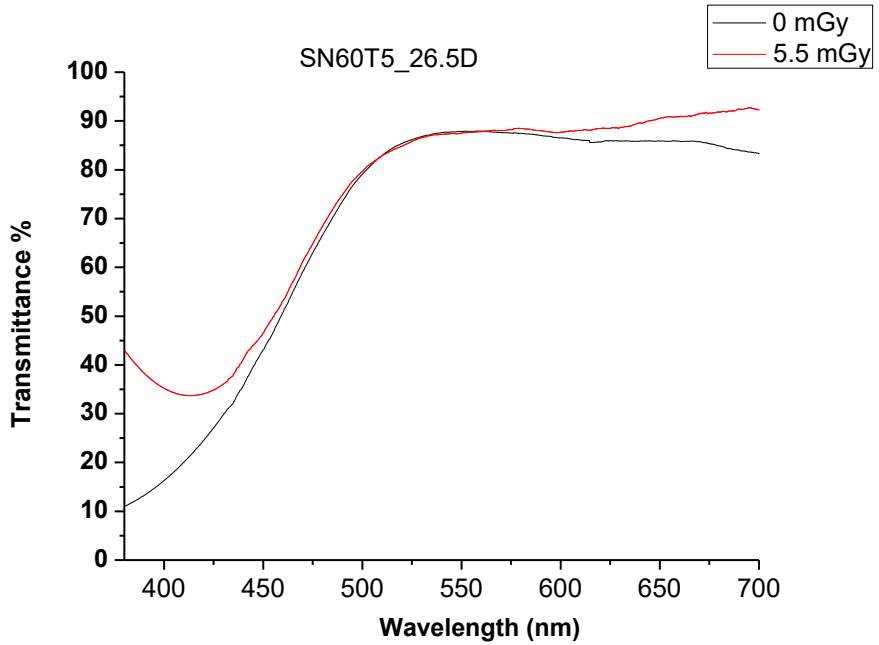
The effect of ionizing radiation on the UV-blue light protection filter of Intraocular lenses

Results: X-ray irradiation of IOL with x-ray at clinical doses used in diagnostics procedures

Yellow azo-dye doped IOL



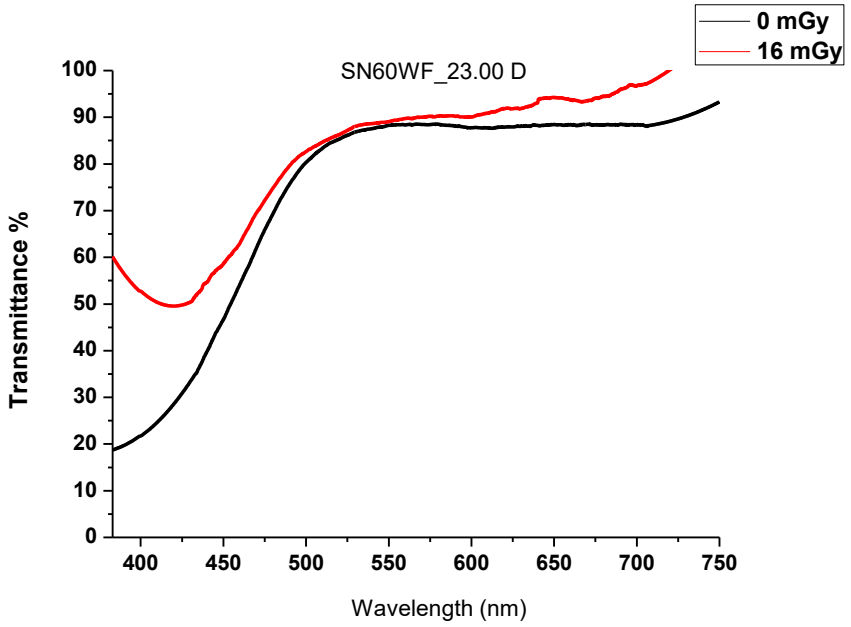
Yellow azo-dye doped IOL



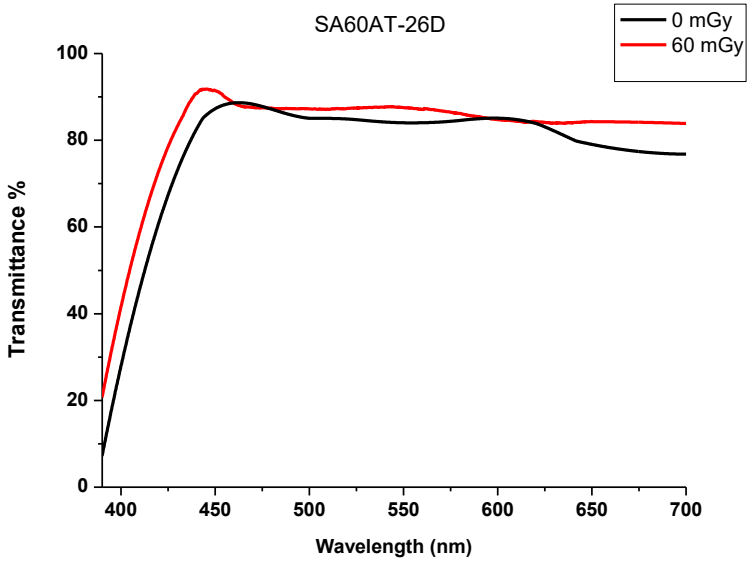
The effect of ionizing radiation on the UV-blue light protection filter of Intraocular lenses

Results: X-ray irradiation of IOL with x-ray at clinical doses used in diagnostics procedures

Yellow azo-dye doped IOL



Undoped IOL



The effect of ionizing radiation on the UV-blue light protection filter of Intraocular lenses

Results:

- Comparing the transmission spectra of each IOL pre- and post-irradiation, we observed that in the UV-blue light region the IOLs show an increased transmittance *T* with a highest *ΔT* change equal to 40% at 16 mGy.
- In the residual visible region the transmittance does not present significant difference.
- In the case of the undoped IOL, the transmittance retains almost the same value.
- Correlating the changes on the transmittance with the opacification of the eye lens, the crystalline natural lens of a 53 and 75 years old person transmits only the 70% and 20% of the visible light respectively, in comparison with the 87-90% and the 84-86% which the implanted IOL transmits pre- and post-irradiation, respectively.

The effect of ionizing radiation on the UV-blue light protection filter of Intraocular lenses

Conclusions

- **The x-ray irradiation at clinical doses used in diagnostics and therapeutics procedures of human eye affects significantly the filter protection of the intraocular lenses against the natural exposure to the damaging UV and short wavelength blue light, while the transmittance in the visible region is slightly reduced.**

The effect of ionizing radiation on the UV-blue light protection filter of Intraocular lenses

References

1. Efstathopoulos EP, Pantos I, Andreou M, Gkatzis A, Carinouet E, et al. “Occupational radiation doses to the extremities and the eyes in interventional radiology and cardiology procedures”, Br J Radiol 84: 0-77. (2011).
2. Efstathopoulos EP, “Occupational eye lens dose in interventional radiology and cardiology: New insights”, Imaging Med. 8. (2016).
3. Ellerin BE, Nisce LZ, Roberts CW, Thornell C, Sabbas A, “The effect of ionizing radiation of intraocular lenses”, Int. J. Radiation Oncology Biol Phys 51: 184–208, (2001).
4. Spyratou E, Antonakos J, Platoni K,Bacharis C,Makropoulou M, et al., “Investigating the Effect of Ionizing Radiation on Intraocular Lenses at Clinical Doses”, Insights Med Phys. Vol. 2 No. 2: 6. (2017).

Thank you for your attention