“Light Transmittance of Explanted Hydrophobic Acrylic Intraocular Lenses with Surface Light Scattering”

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Purpose

Surface light scattering of intraocular lenses (IOLs) is related to subsurface nanogratings, which becomes notable only under oblique light (off-axis light) conditions at an angle of incidence of 30 degrees or greater during slit lamp examination or during image capture at an angle of 45 degrees with Scheimpflug photography.1,4,6 Some studies suggested that IOL light scattering was caused by a surface-bound biofilm.3,5 However, recent studies analyzing explanted lenses in dry and hydrated states as well as analyses under cryo-focused ion beam scanning electron microscopy confirmed that scattering was predominantly caused by phase separation of water (from aqueous humor) as subsurface nanogratings.4 The aim of this study was to investigate the potential role of surface light scattering on the light transmittance of hydrophobic acrylic IOLs made of AcrySof material (Alcon) with or without blue light filter (BLF).

Methods

The following methods were conducted as previously described.2,7 IOLs were obtained from human cadavers (49 lenses total; 36 with BLF), and from finished-goods inventory (controls). The IOLs were explanted from the cadaver eyes and power/mold matched to unused control IOLs. Explanted lenses with their respective control IOLs were fixed in 10% neutral buffered formalin for 1 hour. Proteins on all IOLs were then stained and removed. Briefly, proteins were stained with Coomassie blue G-250 dye. After light microscopic evaluation of the lenses, proteins were removed with a mixture of enzymes (cysteine H and trypsin) and a chelator (ethylene-diaminetetraacetic acid EDTA), and then with a solution of 0.6% sodium hypochlorite in phosphate-buffered saline. The protein-stripped IOLs were rinsed with distilled deionized water and re-stained again with Coomassie blue G-250 reagent to confirm protein removal. Residual stain was washed with the 0.6% sodium hypochlorite solution, and then rinsing in distilled deionized water. The lenses were then allowed to dry overnight at room temperature. Explanted and control lenses were re-hydrated in balanced salt solution (BSS) for at least 15 hours before measurement of light scattering. Light-scattering measurements were obtained using a spectrophotometer (Surg Lasers Imaging, CA). Bright-field and dark-field images were captured for all explanted controls and IOLs before and after hydration. Dark-field images were obtained with a 90-degree off-axis illumination. Surface light scattering was then measured with a Scheimpflug camera (EAS-1000 Anterior Segment Analysis System, Nidek Ltd; Figure 1) with the following settings: flash level 200 W; slit length 10 mm; meridian angle 0. Light transmittance was measured with a Perkin Elmer Lambda 35 UV/Vis spectrophotometer (single-beam configuration with a Datasphere 2000 photometer; Figure 2). Results were expressed as % light transmittance in the visible light spectrum (700-400 nm).

Previous studies measuring light scattering and light transmittance of AcrySof lenses in vitro mostly involved 3-piece designs made of ultraviolet-blocking material.2,3 This is the first study using a single-piece AcrySof lenses explanted from cadaver eyes with known implantation duration, especially with regards to the material with BLF. Protein deposits were removed prior to measurements in order to specifically assess the effect of subsurface nanogratings independent of surface deposits, although a previous study demonstrated that protein films on the IOL surface are not a significant source of light scattering.7 That same study also confirmed that the 0.1 formalin treatment, staining, and protein removal processing steps did not alter the surface chemistry of the AcrySof IOL material.4 A spectrophotometer operated in a single beam configuration with an integrating sphere was used for light transmission measurements. This setup was found to eliminate variations due to lens power, spherical aberration, and misalignment of the IOL in another study. Also, single-beam measurements were unaffected by temperature, and detected real differences due to surface light scattering in comparison to dual-beam configuration.4 In both groups of lenses (with or without BLF), light scattering of postmortem explanted lenses was significantly higher than that of controls. However, this was not associated with a significant decrease in light transmittance.

In conclusion, although surface light scattering of explanted lenses was significantly higher than that of controls and appeared to increase significantly with the use of BLF, the light transmittance of single-piece hydrophobic acrylic lenses with or without blue light filter remained unaffected.5,9

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