CASE REPORT

Snowflake degeneration of a poly(methyl methacrylate) intraocular lens

Hershel Patel, MS, MD, Alec Chaleff, MBA, Neil Patel, MD, Ankit Shah, MD, Chetan K. Patel, FRCOPth, David J.P. Ferguson, PhD, DSc

A 74-year-old pseudophakic woman presented with progressive declining vision in the left eye not improved with refraction. Uneventful extracapsular cataract extraction with insertion of an intraocular lens (IOL) in the left eye had been performed 20 years earlier. Slitlamp examination revealed an opacified IOL that was centered in the pupillary axis. An IOL exchange was performed, and the frosted IOL was examined via scanning electron microscopy (SEM). The central region between the anterior and posterior surfaces of the IOL showed numerous unusual fissures and appeared fractured rather than smoothly cut. This is consistent with snowflake degeneration of a poly(methyl methacrylate) (PMMA) IOL attributed to exposure to ultraviolet (UV) light. The peripheral optic is protected by the iris, so the central optic is affected most. Our findings support the hypothesis that snowflake degeneration of a PMMA IOL is due to UV light exposure. The opacifications were viewed through SEM.

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The word "cataract" has its origins in Latin. It comes from the word "cataractes," which means waterfall. A layperson may associate the lenticular opacity with tempestuous water. Cataract occurs when there is lenticular opacification, which is the most common cause of blindness worldwide and is surgically managed with extraction and intraocular lens (IOL) placement. Modern cataract surgery with IOL implantation is among the safest and most effective medical procedures currently available.[1] The materials used to manufacture IOLs include poly(methyl methacrylate) (PMMA), hydrophilic acrylic hydrophobic acrylic, and silicone.[2]

Despite successful IOL implantation, discoloration and opacification of the prosthetic lens have been documented.[2] These processes have the capacity to disrupt the IOL's optical characteristics, resulting in light scattering and a reduction in light transmittance.[2] Progressive degeneration of the prosthetic biomaterial (snowflake degeneration) and surface calcific precipitation (calcification) have been reported to be long-term complications after implantation.[2]

Clinical manifestations of IOL opacification include blurry vision and glare.[2] Poly(methyl methacrylate) IOLs may experience progressive snowflake degeneration 10 to 20 years after implantation, whereas hydrophobic acrylic IOLs typically experience calcification within 2 years.[2] Similar to a cataract, the severity of IOL snowflake degeneration may not completely correlate with the degree of visual impairment and/or higher-order aberrations.[3] Thus, the decision to explant the prosthetic IOL should be patient specific.

CASE REPORT

A 54-year-old woman had uneventful extracapsular cataract extraction and implantation of a 21.0 diopter posterior chamber IOL (model 3264S, Iolab Inc.) in the left eye in July 1991. Twenty years later, she presented to John Radcliffe Hospital with complaints of progressive painless decline in her vision. The corrected distance visual acuity was 20/60, a significant drop from 20/20 several years earlier. On slitlamp examination, a central IOL opacification was observed over the central visual axis. Careful evaluation with biomicroscopy did not identify posterior capsule opacification (PCO) as the cause of the vision loss. A high-resolution photograph of the affected IOL, highlighting vacuolated structures impeding the central visual axis, was taken in situ on the day of presentation (Figure 1).

Intraocular lens exchange was scheduled. An in situ preoperative photograph of the affected IOL was taken during the procedure, highlighting the increased severity of opacifications over regions most exposed to ultraviolet (UV) light (Figure 2). After it was removed, the frosted IOL was placed in a formalin solution

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From the University of South Florida Eye Institute (H. Patel, Chaleff, N. Patel, Shah), Morsani College of Medicine, Tampa, Florida, USA; the Department of Ophthalmology (C.K. Patel) and Nuffield Department of Clinical Laboratory Sciences (Ferguson), University of Oxford, John Radcliffe Hospital, Oxford, United Kingdom

Corresponding author: Alec Chaleff, MBA, University of South Florida Eye Institute, 12901 Bruce B. Downs Boulevard, MDC 21, Tampa, Florida 33612, USA. E-mail: alec.chaleff@gmail.com.

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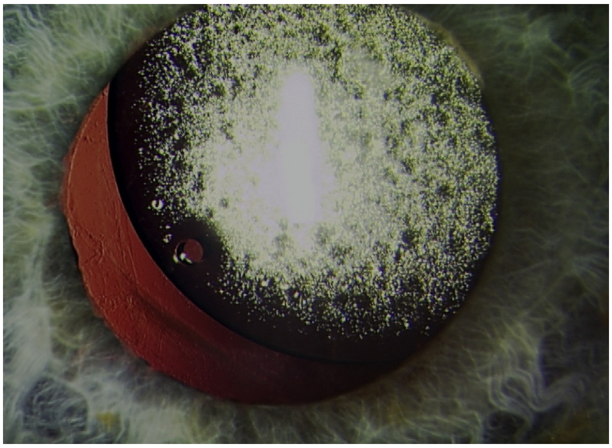

Figure 1. In situ high-resolution photograph of the affected IOL highlighting vacuolated structures impeding the central visual axis taken on the day of presentation.

and sent to the pathology laboratory for further examination. The specimen was washed and processed for scanning electron microscopy (SEM). This involved cutting the IOL in half so both surfaces could be examined. Significantly more force was required to splice this IOL using a scalpel than had been required to splice previous IOLs. The 2 halves were mounted to expose the anterior and posterior surfaces, and the sample was sputter coated with gold prior to SEM examination.

The SEM examination of the explanted IOL showed both surfaces of the optic were smooth with no evidence of surface deposition or calcification (Figure 3, *a*). This is consistent with the appearances of control IOLs. However, when the cut surface was examined, the central region between the anterior and posterior surfaces exhibited an uneven irregular appearance (Figure 3, *b*), which is not seen in control IOLs. The initial layers of the anterior and posterior sides of the IOL appeared to be smoothly cut, whereas the central region showed multiple unusual fissures and circular plate-like structures (Figure 3, *c*). Although the material between the plates showed evidence of fracture, the plates appeared undamaged (Figure 3, *d*).

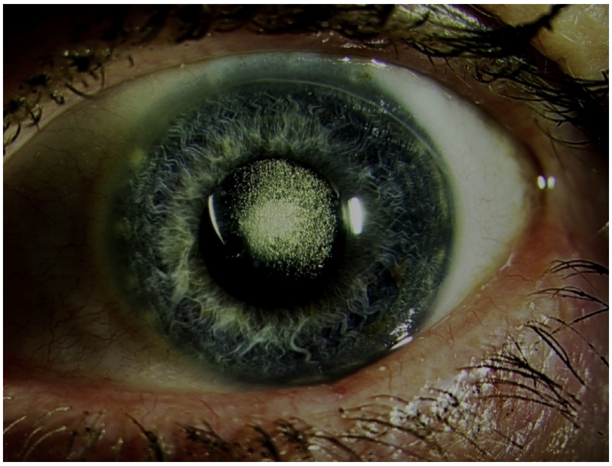

Figure 2. In situ preoperative photograph of the affected IOL highlighting the increased severity of opacifications over regions most exposed to UV light.

DISCUSSION

Snowflake degeneration of a PMMA IOL is a recently recognized, albeit rare, late complication of modern IOL implantation following cataract extraction. The opacification of the IOL occurs 10 years or more after implantation.[4,5] Careful examination is often needed to distinguish this significant finding from the more common PCO as both snowflake degeneration and PCO may contribute to painless progressive vision loss in pseudophakic patients years after surgery. The lesions are typically described as whitish-brown opacities usually located in the central, midperipheral, and anterior third of the IOL.[4]

The lesions are frequently discrete and localized and, not uncommonly, may increase in size and coalesce with time.[5] Dry snowflake lesions should be differentiated from fluid-filled intraoptical vacuoles, which represent glistenings.[5] Glistenings have been most frequently described in hydrophobic acrylic IOLs but may be seen in PMMA material.[5] Dry snowflake PMMA IOL-degenerated lesions are thought to be due to prolonged UV light exposure. This hypothesis is supported by the observation of snowflake lesions concentrated at the center of the optic with minimal degeneration beneath the iris.[5,6]

Many hundred thousand patients have received PMMA IOLs. However, many of these patients have died.[7] It is clinically useful to recognize snowflake degeneration in PMMA IOLs to prevent unnecessary diagnostic testing for systemic etiologies.[6,8]

Although UV light exposure certainly occurs, the change in the manufacturing process of PMMA IOLs that occurred during the 1980s to the mid-1990s may be a contributing factor.[6–9] The exact pathogenesis of snowflake degeneration in PMMA IOLs is still unknown. It is likely that significant numbers of patients have IOLs that have developed varying degrees of the snowflake lesions.[8] Most of these cases are asymptomatic and do not require further management.[8]

Our report documents snowflake degeneration of a PMMA IOL, an uncommon but clinically significant late complication of IOL implantation. The report provides high resolution ex vivo SEM analysis of the degenerated IOL, showing a centralized, focal plate-like pattern consistent with UV light–induced PMMA material degeneration. The central location receives the most severe UV light exposure and also corresponds to the patient's symptoms of difficulty reading and seeing in photopic conditions, all of which cause pupillary constriction. The peripheral optic receives relative protection from the iris and is uninvolved. This case of snowflake degeneration of a PMMA IOL not only supports the hypothesis of UV light exposure causing the described lesions seen in this rare clinical entity, but also provides high-resolution SEM images describing the changes seen at a microscopic level.

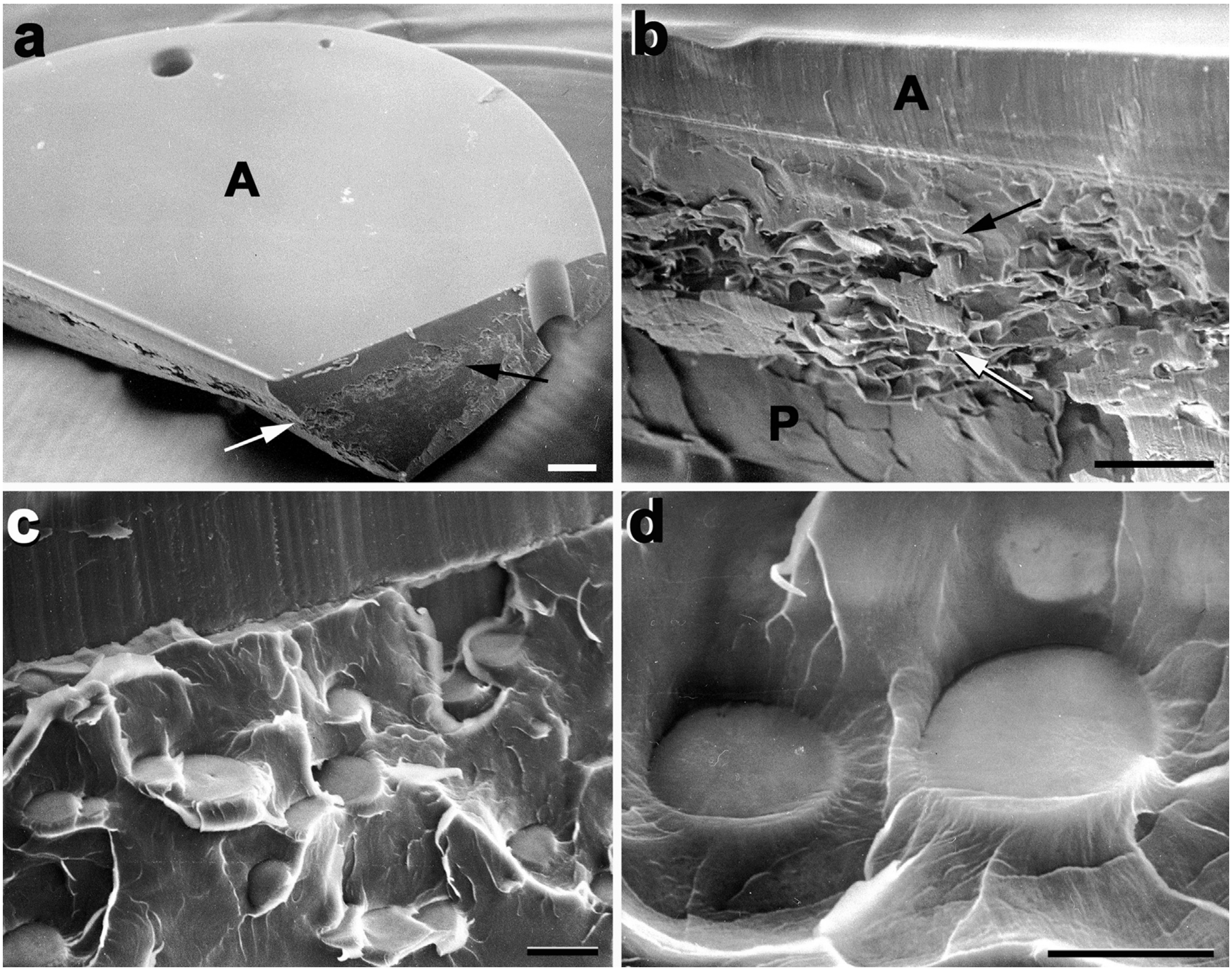

Figure 3. Low power images showing half of the cut IOL with the smoother anterior surface (*a*) uppermost. Note the irregular appearance of the central region of the cut surface (*arrows*) (bar = 200 μm). *b*: Enlargement of the cut surface showing the relatively smooth cut surface associated with the anterior (*A*) and posterior (*P*) regions but with numerous fissures in the central region (*arrows*) (bar = 100 μm). *c*: Detail showing the fissures and circular plate-like structures (bar represents 10 μm). *d*: Enlargement showing the smooth appearance of the plate-like structures surrounded by fractured material (bar = 10 μm).

REFERENCES

1. Al-Otaibi AG, Al-Qahtani ES. Polymethyl methacrylate intraocular lens opacification 20 years after cataract surgery: a case report in a tertiary eye hospital in Saudi Arabia. Saudi J Ophthalmol 2012; 26:105–107. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3729466/pdf/main.pdf. Accessed September 14, 2016
2. Michelson J, Werner L, Ollerton A, Leishman L, Bodnar Z. Light scattering and light transmittance in intraocular lenses explanted because of optic opacification. J Cataract Refract Surg 2012; 38:1476–1485
3. Tan LT, Shuttleworth GN. Asymptomatic snowflake degeneration in a polymethyl methacrylate (PMMA) intraocular lens implant. Ann Ophthalmol 2008; 40:173–174
4. Garrott H, O'Day J. Snowflake degeneration of an intraocular lens [letter]. Clin Exp Ophthalmol 2004; 32:534–535
5. Dahle N, Werner L, Fry L, Mamalis N. Localized, central optic snowflake degeneration of a polymethyl methacrylate intraocular lens: clinical report with pathological correlation. Arch Ophthalmol 2006; 124:1350–1353. Available at: http://archopht.jamanetwork.com/article.aspx?articleid=417857. Accessed September 14, 2016
6. Apple DJ, Werner L. Complications of cataract and refractive surgery: a clinicopathological documentation. Trans Am Soc Ophthalmol 2001; 99:95–107. discussion, 107–109. Available at: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1359028/pdf/11797325.pdf. Accessed September 14, 2016
7. Schmidbauer JM, Apple DJ, Peng Q, Arthur SN, Vargas LG. Trübung einer PMMA-Intraokularlinse [Cloudiness] of a PMMA intraocular lens. Ophthalmologe 2002; 99:306–307
8. Apple DJ, Peng Q, Arthur SN, Werner L, Merritt JH, Vargas LG, Hoddinott DSM, Escobar-Gomez M, Schmidbauer JM. Snowflake degeneration of polymethyl methacrylate posterior chamber intraocular lens optic material; a newly described clinical condition caused by unexpected late opacification of polymethyl methacrylate. Ophthalmology 2002; 109:1666–1675
9. Schmidbauer JM, Werner L, Apple DJ, Pandey SK, Izak AM, Trivedi RH, Macky TA, Auffarth GU, Peng Q, Arthur SN, Escobar-Gomez M, Ma L, Vargas LG. Postoperative Trübung von Hinterkammerlinsen – eine Übersicht [Postoperative opacification of posterior chamber intraocular lenses – a review]. Klin Monatsbl Augenheilkd 2001; 218:586–594

FINANCIAL DISCLOSURE

None of the authors has a financial or proprietary interest in any material or method mentioned.