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Steam-like clouding observed on anterior surface of intraocular lens developed soon after implantation

Ichiro Ota, Goichiro Miyake, Tetsu Asami, Kensaku Miyake*

Shohzankai Medical Foundation Miyake Eye Hospital, Nagoya, Japan

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ABSTRACT

Purpose: To report our findings in three cases of a clouding of the anterior surface of an implanted intraocular lens that developed within 14 days after implantation.

Observations: Three eyes were implanted with the same model IOL and a steam-like clouding developed on the anterior surface of the IOL. The clouding occurred on days 4, 7, and 14 after the implantation in an area of the IOL that was in contact with the aqueous humor. The clouding was accompanied by a reduction of vision in all cases but without any other abnormalities such as inflammation. The clouding was resolved by irrigation and aspiration of the anterior chamber in 2 cases at 2 and 34 days after the onset, and a spontaneous disappearance in 1 case at 14 days after the onset of the clouding. After the disappearance of the clouding, the visual acuity improved, and there were no recurrences. The solution used to irrigate the anterior chamber was collected and examined to confirm the absence of cellular materials. Elemental analyses confirmed that sodium and chloride were the predominant ions. The IOL implanted was the XACT lens (Advanced Vision Science, USA) which is a hydrophobic acrylic IOL and is characterized by having higher water content compared to other IOLs. In addition, it is packaged in 0.9% saline to maintain the pre-hydrated condition. These aspects may be related to the cause of the clouding. This IOL was implanted in 3271 eyes in our clinic, and 3 of them (0.09%) developed this clouding.

Conclusions and importance: We report our findings in 3 eyes that developed a clouding on the anterior surface of the lens soon after implantation. The clouding was localized to the area in contact with the aqueous. The cause of the clouding was not determined.

1. Introduction

The irregularities that develop on implanted intraocular lenses (IOLs) include deposits due to inflammation,[1,2] calcification,[3–7]discolourations,[8] a glistening, a whitening, and the presence of sub-surface nano-glistening particles.[9–14] Other complications related to IOL implantations are still being reported.[15,16] A standard for evaluating the manufacturing process and quality of IOLs has been proposed.[17] We report our findings in 3 eyes that developed a clouding of the anterior surface of the IOL. This kind of clouding has not been reported.

2. Observations

This study was approved by the Institutional Review Board of Shohzankai Medical Foundation, Miyake Eye Hospital, Nagoya, Japan, and the procedures used conformed to the tenets of the Declaration of Helsinki. A signed informed consent to perform the surgery was obtained from the 3 patients after they were given full explanations of the nature of the surgery and possible complications. They also gave approval for our use of any data collected during the surgery in future publications. Anonymity was assured.

All 3 cases were treated surgically and medically similarly. Nepafenac 0.1% (Nevanac, Alcon Laboratories, Inc. Fort Worth, US) and fluorometholone 0.1% (Flumetholon, Santen Pharmaceutical Co. LTD. Osaka, Japan) were used as anti-inflammatory drugs and were applied 3/day beginning the day before and for 5 weeks after the surgery. In addition, levofloxacin 0.5% (Santen Pharmaceutical Co. LTD. Osaka, Japan) was applied 5/day beginning two days before the surgery and 3/day after surgery for 2 weeks postoperatively.

The surgical techniques were also the same in all 3 eyes. A small incision requiring no or 1 suture was made and a continuous curvilinear capsulorrhexis and phacoemulsification were performed by one of the authors. Then a 3-piece acrylic IOL (Eternity Natural®, Santen Pharmaceutical Co. LTD. Osaka, Japan, commercial name in Japan, details are described in the Table 1[18]).

* Corresponding author. Shohzankai Medical Foundation, Miyake Eye Hospital, 3-14-20, Ozone, Kita-ku, Nagoya, 462-0825 Japan.
E-mail address: miyake@spice.or.jp (K. Miyake).

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Table 1
Characteristic features of the intraocular lens material implanted.[18]

IOL/Manufacturer	XACT/Advanced Vision Science, Goeta, CA, USA
Material Composition (All With UV filters)	Copolymer of hydroxyethyl methacrylate, polyethylene glycol phenyl ether acrylate and styrene, crosslinked with ethylene glycol dimethylacrylate
Refractive Index	1.54
Water Content (%)	4.0
Contact Angle in Water (°)	76°
Packaging	Prehydrated in 0.9% saline
Manufacturing Method	Lathe cut at room temperature
FDA Approved in USA	Yes

Abbreviations: IOL, intraocular lens; UV, ultraviolet.

A total of 3271 eyes had this model IOL implanted between December 2008 to July 2016, and 3 developed this abnormal clouding (0.09%). We present our findings in these 3 eyes.

Case 1 was a 70-year-old man with a medical history of hyperuricemia and hyperlipemia. He underwent phacoemulsification and IOL implantation for senile cataract. A mild cellular infiltration was noted in the anterior chamber on the day after the surgery but the degree of inflammation was within the normal range. The IOL was well positioned, and the best-corrected visual acuity (BCVA) was 20/20. Fourteen days after the surgery, the patient complained of blurred vision, and slit-lamp examination showed mild inflammation of the anterior chamber and the flare was measured to be 11.2 (FM-600 Laser Flare Meter) 11.2. However, a steam-like clouding consisting of small dot-like whitish-gray material was detected on the anterior surface of the optic of the IOL by slit-lamp biomicroscopy (Fig. 1 top, center). The BCVA had reduced to 20/25. Because the degree of inflammation remained within the normal range at 10.2, the patient was not treated but closely monitored. Because the clouding of the lens surface did not diminish, the anterior chamber was irrigated using an irrigation and aspiration tip 2 days after the onset. These procedures resulted in removing the clouding, and the lens surface became clear. The lens remained clear the next day (Fig. 1 bottom) and BCVA improved to 20/20. After approximately 7 years after the onset, the lens clouding has not recurred and the anterior chamber remained normal.

The solution used for irrigation and aspiration of the anterior chamber was centrifuged and analyzed. Light microscopy showed that no cellular materials were present in the solution. However, elemental analysis detected the presence of sodium and chlorine as expected from the BSS PLUS®250 (Alcon Laboratories, Inc. Fort Worth, US) irrigating solution (Figs. 2 and 3). In addition, the BSS solution contained 0.0184% oxiglutatione with a pH of 7.2–8.2 and osmolarity of 1.0–1.1.

Case 2 was a 67-year-old woman without any medical history. She underwent phacoemulsification and IOL implantation for senile cataract. A mild cellular infiltration was noted in the anterior chamber on the day after the surgery but the amount of flare was 12.2 which is within the normal range. The anterior chamber and IOL findings were all normal. Her BCVA was 20/20. The examination on day 7 after the surgery showed a steam-like clouding on the anterior surface of the IOL. The clouding was caused by an accumulation of small dot-like whitish-gray material, at the inferior part of the anterior surface of the optics covering about 2/3 of the lens (Fig. 1 top, center). The BCVA had decreased to 20/25, and the patient complained of blurred vision. She had no other symptoms and the amount of flare was 11.4. Her other clinical findings were normal. Because the clouding of the lens surface did not diminish, the anterior chamber was irrigated using an irrigation and aspiration tip on 34 days after the onset. This cleared the lens surface. The lens remained clear the next day (Fig. 1 bottom), and BCVA improved to 20/20. The lens clouding has not recurred at approximately 2 years after the onset.

The aspirated anterior chamber solution was centrifuged and examined, and the results showed no cellular materials in the solution. The results were same as in Case 1 (Figs. 2 and 3).

Case 3 was a 67-year-old man with an ocular history of asteroid hyalosis but without any medical history. He underwent phacoemulsification and IOL implantation in his right eye. Slight cellular infiltration was detected in the anterior chamber on the next day but the amount of flare was 14.2 which was within the normal range of inflammation. No other abnormalities were present including that of the IOL. His BCVA was 20/25. Four days after surgery, while the level of anterior chamber inflammation was within the normal range, a steam-like clouding with an accumulation of small dot-like whitish-gray material was noted on the surface of the IOL optic (Fig. 1 top, center). The BCVA had decreased to 20/32, and the patient complained of blurred vision. After 1 week, the clouding had slightly improved, and after another week the clouding had totally disappeared and BCVA improved to 20/20. The surface of the IOL findings were clear. At one year and seven months after the onset, all clinical findings were within the normal limits and without recurrence of the lens clouding.

3. Discussion

Several types of opacifications and deposits have been reported to be present on the anterior surface or within the optic of implanted postoperative IOLs.[1–14] The opacifications include calcification in hydrogel[3,4] and silicone IOLs,[5–7] and a glistening or whitening or subsurface nano-glistening (SSNG) in hydrophobic acrylic IOLs.[9–14] These two types of abnormalities should be differentiated from the steam-like clouding reported in our three cases.

First, the time of onset was different; in cases with a silicone IOL, the deposition of calcium occurs intraoperatively with the use of Healon GV, a highly concentrated solution of high molecular-weight hyaluronate sodium, in one type of IOL.[5,6] An opacification of an IOL can also occur several years postoperatively in eyes with asteroid hyalosis.[7] In cases with a hydrogel IOL, calcified deposits can appear several months postoperatively.[3,4] In cases with a hydrophobic acrylic IOL, the glistening or SSNG does not occur shortly after surgery but begins at longer postoperative times.[9–14] Our three cases developed a steam-like clouding at 4, 7, and 14 days postoperatively.

Second, the size and location of the clouding were different in our three eyes. Crystalline or calcium deposits cover the entire IOL surface including the anterior and posterior surfaces.[3–7] SSNG or glistening opacities are fluid-filled microvacuoles that form within just below the surface of the optics of the IOL and not on the surface.[14] On the other hand, our three cases developed steam-like clouding only on the anterior surface of the optic where it came into contact with the aqueous humor.

Lastly, the outcome, symptoms, treatment, and related conditions were different for the three eyes. The steam-like clouding and calcium deposits were different in several ways. First, the former occurs in cases with an implanted hydrophobic acrylic IOLs, and the latter occurs in cases with silicon and hydrogel IOLs.[3–7] Second, the calcium deposits are associated with some specific condition such as the use of Healon GV[3–5] or eyes having asteroid hyalosis.[7] In cases with calcium deposits, the reduction of vision is generally greater and may require additional surgical interventions such as IOL exchange compared to those with steam-like clouding. The differences between the three cases and those with SSNG is also clear; the symptoms in eyes with clouding appear at an early postoperative time and is acute and benign whereas that of SSNG is chronic and longstanding. A reduction of vision is present in cases with steam-like clouding but not in those with SSNG, and the former may require surgical intervention but the latter generally requires no treatment.

The mechanism(s) that cause the cloudy IOL was not definitively determined. In addition, the nature of the SSNG or glistening,[14] fluid-filled microvacuoles that form within the IOL optics when the IOL in an aqueous environment was not determined. The factors that should be considered for the clouding IOL are the IOL materials, manufacturing

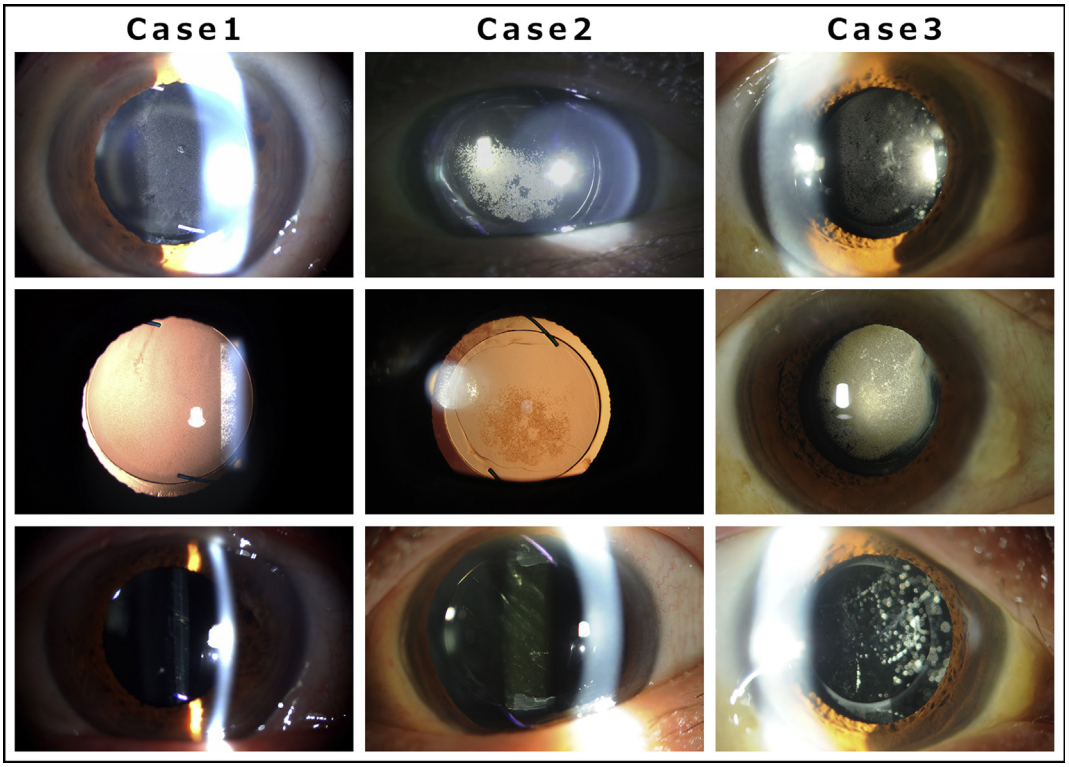

Fig. 1. Slit-lamp biomicroscopic appearances.
Case 1 was a 70-year-old man with a medical history of hyperuricemia and hyperlipemia. He underwent phacoemulsification and IOL implantation for senile cataract.Top: Slit-lamp biomicroscopic appearance of the anterior surface of the implanted intraocular lens (IOL) under slit beam illumination. Note the small dot-like whitish-gray material.Center: Slit-lamp biomicroscopic appearance of the anterior surface of the IOL under retro illumination. Note the whitish-gray dots.Bottom: Slit-lamp bio microscopic appearance after aspirating the materials.
Case 2 was a 67-year-old woman without any medical history. She underwent phacoemulsification and IOL implantation for senile cataract.Top: Slit-lamp biomicroscopic appearance of the anterior surface of IOL under defuse illumination. Whitish dot-like materials can be seen at the inferior region of the IOL.Center: Observation of the same region under retro-illumination.Bottom: Slit-lamp biomicroscopic appearance after removing the materials.
Case 3 was a 67-year-old man with an ocular history of asteroid hyalosis but without any medical history. He underwent phacoemulsification and IOL implantation in his right eye.Top: Slit-lamp biomicroscopic appearance of the anterior surface of the IOL under slit beam illumination. Note the diffused steam-like clouding. Asteroid hyalosis is present in the vitreous.Center: Observation of the same region under diffuse illumination. Accumulation of small dot-like whitish-gray materials is easily seen.Bottom: Appearance of the same area 2 weeks after the onset of the clouding. Steam-like clouding is no longer noticeable under slit-lamp illumination. Dense asteroid hyalosis is present in the vitreous cavity.

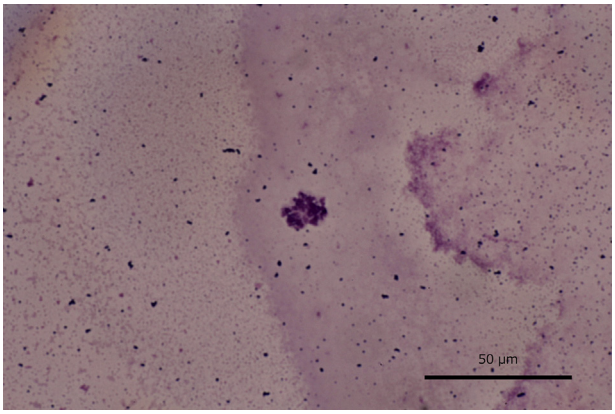

Fig. 2. Microscopic appearance of collected irrigation solution stained with Giemsa staining.
The irrigation and aspiration solution was centrifuged and examined under a stereoscopic microscope using light Giemsa staining. Note amorphous tiny substances and absence of cellular materials.

techniques, packaging methods, and associated ocular conditions such as blood-aqueous barrier disruption.[14] The mechanism has not been determined but it may be related to the long-term phase separation of the water near the IOL.[14] The mechanism for the formation of calcium deposits on the surface of hydrogel or silicone IOLs has also not been fully determined. An excessive level of calcium or phosphate from the intraocular solutions or osmotic gradient created by the viscoelastic material that increases the calcium concentration usually with the use of BSS Plus has been suggested as a possible cause of the clouding.[3,5,6] Inflammation can be eliminated as the cause of the clouding because the 3 eyes did not show any signs of inflammation, and inflammatory cells were not present in the collected irrigation fluid. The early post-operative nature of the clouding suggests that the packaging in 0.9% saline to maintain pre-hydrated condition may be a possible mechanism. The fact that the deposits on the anterior surface of the optic were localized to the area which came in contact with the intraocular irrigating solution or the aqueous humor may be related to the origin of this kind of clouding. The interaction of this particular hydrophobic IOL surface and chemical composition of the irrigating solution, viscoelastic material, and the aqueous humor may play a role. Among the previously reported deposits, calcium deposits have some common features but we were unable to detect significant amount of calcium by elemental analysis of the irrigation fluid from our eyes.

4. Summary

We described the findings in 3 cases with clouding of the anterior surface of the optic of an implanted IOL. Similar alterations have also not been reported by the manufacturer during the testing phase of the

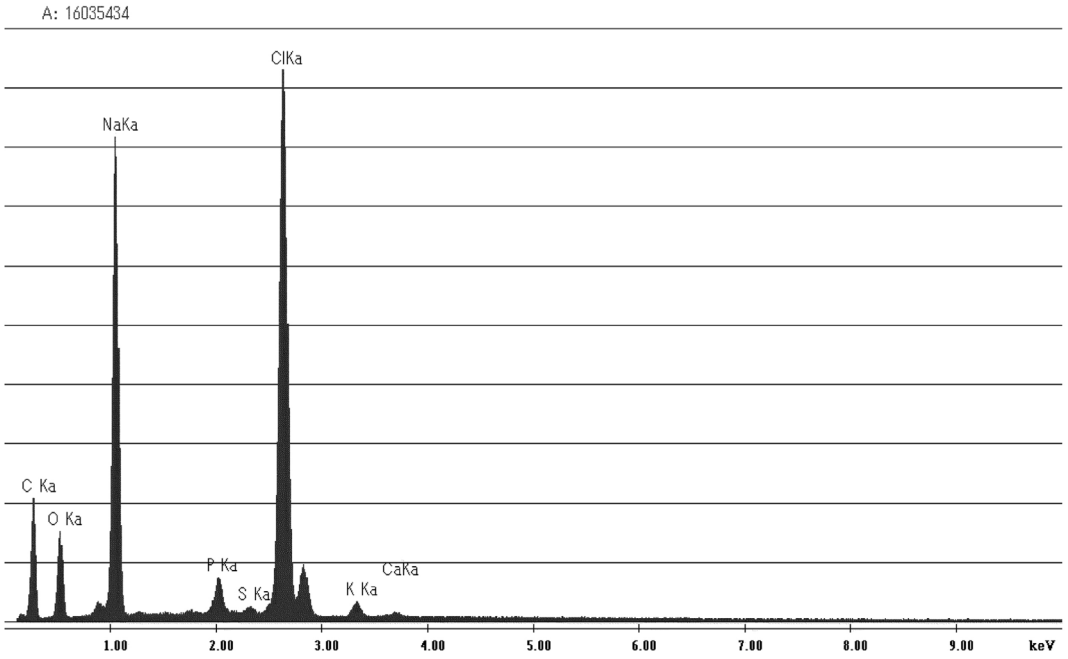

Fig. 3. X-ray energy spectrum for elemental analysis.
X-ray energy spectrum shows that the particles to be sodium and chloride of high density.

IOL. The onset was 4, 7, and 14 days after the implantation. The deposits disappeared spontaneously in 1 case at 14 days after the onset, and 2 cases required irrigation with an irrigation and aspiration tip at 2 and 34 days after the onset. During the onset, no inflammatory signs were detected except for a decrease in the visual acuity, which recovered after the clouding was cleared. Although no specific cause was found, the water content of this IOL is slightly higher and is packaged in 0.9% saline to maintain pre-hydrated condition.[18] These features may be related to the cause of the surface deposits.

Patient consent

The patients consented to publication of the case in writing and orally.

Disclosures

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Conflicts of interest

The authors declare that there is no conflict of interests regarding this paper.

Authorship

All authors attest that they meet the current ICMJE criteria Authorship.

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