• Letter to the Editor •

Particles, deposits and sediments: unravelling the complexities of IOL opacification

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Dear Editor,

We report a case illustrating the morphological and compositional characteristics of intraocular lens (IOL) turbidity. Hydrophilic IOL has been frequently used with the advancement of materials because of its good chemical stability and high-temperature resistance. IOL opacification is one of the infrequent complications following cataract extraction and IOL implantation manifested by the appearance of different deposits on the IOL surface or inside the IOL. They are often caused by higher ultraviolet radiation levels and morphologically appear flaky[1]. In hydrophilic IOL, due to the presence of a hydroxyl group, which makes it hydrophobic, ions and small molecules within the liquid are easily retained. Therefore, hydrophilic IOL shows inorganic salt deposits with calcium elements as the primary element, which can appear as particles or have a shell-like morphology[2-3]. In this report, we describe the case of a hydrophilic acrylic IOL turbidity.

The patient was a 77-year-old woman who presented with a complaint of “progressive visual deterioration in the left eye over the past six months”. The patient had a hydrophilic IOL implanted in her left eye six years earlier, and IOL implantation was performed with clear and intact implanted IOL with no abnormalities. Prior to the removal of the opacified IOL, the patient’s best-corrected visual acuity (BCVA) in the affected eye was 0.1, measured using a Snellen chart. Intraocular pressure was 11 mm Hg, assessed by Goldmann applanation tonometry, without the use of any IOP-lowering medications. The IOL was well-centered within the capsular bag, and no additional abnormalities were detected on slit-lamp or fundus examination. The patient had no systemic or genetic diseases or history of ophthalmic surgery other than phacoemulsification and IOL implantation. Following the principles of the Declaration of Helsinki, the ethical approval was obtained (2022-KY-0006-001), the patient gave informed consent and signed a written agreement.

The opacified portion of the observed IOL can be divided into three parts: 1) The centre section had crusty turbidity, with an uneven morphology and a granular white-to-transparent transition. 2) Uneven ring opacification was observed at the outer part of the optical component, granular deposits were observed in the transition zone of the monofocal IOL optic. 3) The two loops of the IOL show a gradual transition from outer to inner granular deposits (Figure 1).

Scanning electron microscopy (SEM) showed that deposits are present in the area where the optical component connects to the loop. An elemental analysis of the area reveals that sodium and phosphorus peaks alongside the carbon and oxygen elements are inherent in the IOL, with a low calcium content (Figure 2B). At the edge towards the opacification region, rounded opaque particles are observed. This region shows a significant increase in calcium content (Figure 2C). The opaque particles are seen to be larger, rougher and denser in the outer ring of opacified densities in the IOL optical component. Inside, there are some flaky deposits with unique morphology. The elemental analysis shows elevated calcium and phosphorus peaks, along with sodium and bromine elements (Figure 2D). Another, more delicate, granular-like deposit, was observed in another field of view in this region with a more complex composition of elements, with visible sodium, chloride, potassium and aluminium peaks (Figure 2E).

Within the opacified region in the centre, the less turbid portion demonstrates an increase in the proportion of fine grains in the presence of coarse particles. The fine-grained particles are denser, and their composition is still dominated by calcium and phosphorus, sodium, chlorine, potassium and rubidium peaks

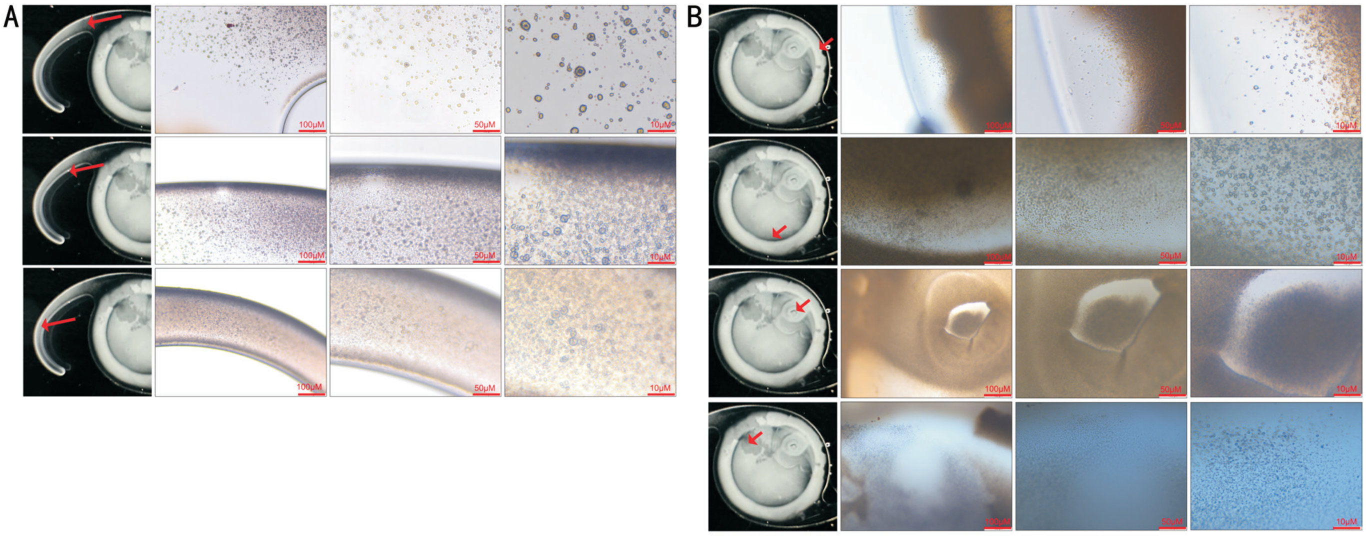

Figure 1 Morphology of opacified IOL under an optical microscope A: Observing the opacified IOL indicated by an arrow; B: Observations of different regions in the optical component of the opacified IOL indicated by the arrow. IOL: Intraocular lens.

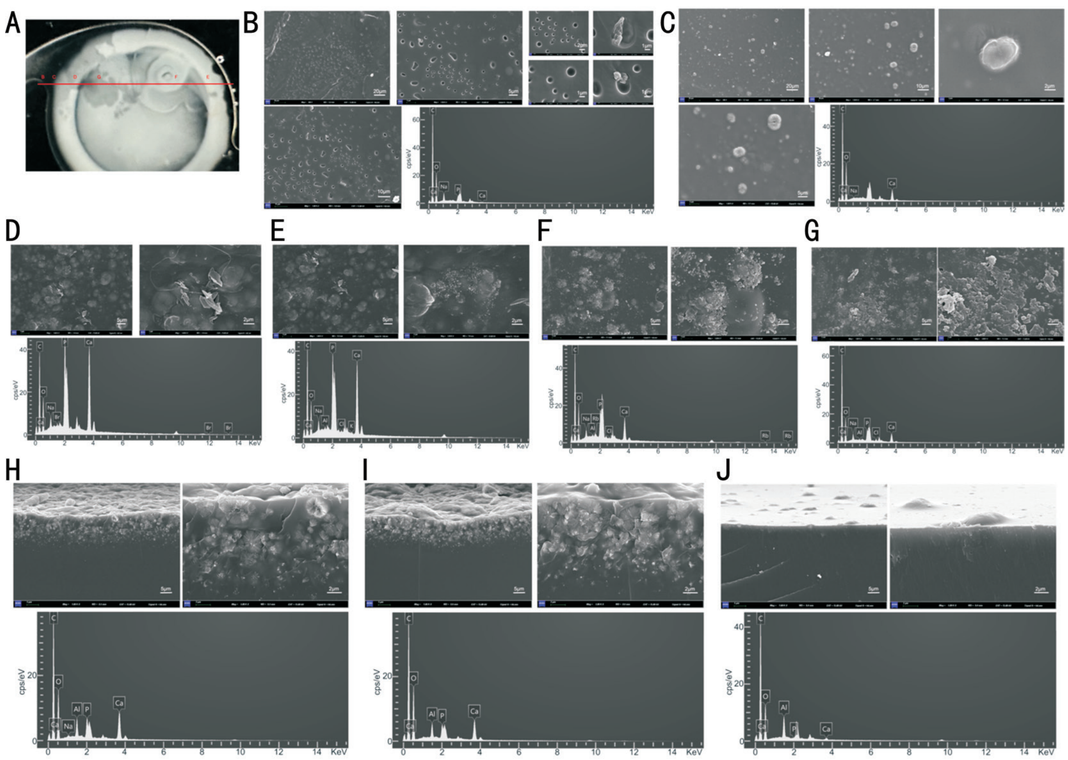

Figure 2 SEM and energy-dispersive X-ray spectroscopy scanning of the opacified IOL A: The scanning area; B-G: SEM photos and energy-dispersive X-ray spectroscopy analyses of different regions with different magnifications; H: The outer ring opacification; I: The central opacification; J: The transparent section. SEM: Scanning electron microscopy; IOL: Intraocular lens.

are also visible (Figure 2F). More dense deposition of fine-grained particles can be observed in the more turbid portion and the shell-like portion. Some are fused into flakes, and sodium, calcium, phosphorus, chlorine and aluminium peaks are visible in the fine-grained particle view. The composition is similar to that of the fine-grained particles in the centre of the opacification, with slightly lower calcium content (Figure 2G).

The central region of the opacified IOL is observed as having a fine-grained surface in cross-section oblique photographs. The sediments are rounded and agglomerated, deposited towards the interior of the IOL, with larger particles near the surface. Elements such as calcium, phosphorus, aluminium peaks and a small percentage of sodium are visible. The composition is similar to that of the fine-grained particles in the centre of the opacification but lacks chlorine (Figure 2H). In the outer annular opacified area of the IOL, which is seen in oblique illumination to have a coarser surface. The deposits are also rounded and clump-like, with no specific morphology. The elemental analysis reveals calcium, phosphorus, and aluminium peaks, which are consistent with the previous site. A lack of chlorine, potassium and sodium was also observed compared to the fine-grained particles deposited on the peripheral surface (Figure 2I). In addition, for the transparent region of opacified IOL, circular bumps were visible on the obliquely illuminated surface, with a slight variation in the density of the bump cross-section, and no significant deposition on the cut surface. Elemental analysis showed phosphorus, aluminium and shallow calcium peaks (Figure 2J).

In conclusion, the transparent portion of the opacification IOL has a low calcium content, and the opacified region exhibits a granular appearance. The degree of turbidity increases with denser particle aggregation and higher calcium content. Previous studies have suggested that deposition may play a contributory role in the development of IOL opacification[4-5]. The particles in the outer opacified region are coarser and primarily consist of calcium, gradually becoming finer towards the central region. Calcium and phosphorus elements dominate the central portion, but the composition becomes more complex. The presence of different elements leads to the appearance of unique deposition morphologies on the surface. Studies have suggested that these unique elements may originate from the surgical instruments used during the initial surgery[6], but a direct correlation cannot be confirmed.

So we can conclude: 1) The transparent surface of hydrophilic IOL is not smooth, with circular protrusions and slightly higher density; however, it does not affect transparency. 2) The opacification of hydrophilic IOL appears granular, with different sizes and shapes appearing in various parts of the IOL, and the particle density is related to the degree of turbidity. 3) Calcium is a prerequisite for forming precipitated particles and mixing different elements can cause surface particles to create unique shapes. However, internal precipitation reflects the presence of calcium particles.

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REFERENCES

1 Kanclerz P, Yildirim TM, Khoramnia R. Microscopic characteristics of late intraocular lens opacifications. *Arch Pathol Lab Med* 2021;145(6):759-767.

2 Izak AM, Werner L, Pandey SK, *et al*. Calcification of modern foldable hydrogel intraocular lens designs. *Eye (Lond)* 2003;17(3):393-406.

3 Stanojcic N, Hull C, O'Brart DP. Clinical and material degradations of intraocular lenses: a review. *Eur J Ophthalmol* 2020;30(5):823-839.

4 Tripodi S, Toro MD, Rejdak R, *et al*. Qualitative and quantitative analysis of an explanted opacified hydrophilic IOL after over two years from cataract surgery. *Eur J Ophthalmol* 2023;33(6):NP28-NP34.

5 Mak ST, Wong AC, Tsui WM, *et al*. Calcification of a hydrophilic acrylic intraocular lens: Clinicopathological report. *J Cataract Refract Surg* 2008;34(12):2166-2169.

6 Sato S, Matsui H, Sasaki Y, *et al*. The efficiency of X-ray microanalysis in low-vacuum scanning electron microscope: deposition of calcium on the surface of implanted hydrogel intraocular lens (IOL). *J Submicrosc Cytol Pathol* 2006;38(1):1-4.