Original Article

Liquefied after cataract and its surgical treatment

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Aims: To describe liquefied after cataract (LAC) and its surgical management following an uneventful phacoemulsification with posterior chamber in-the-bag intraocular lens (IOL) implantation and continuous curvilinear capsulorrhexis (CCC). **Design:** Interventional case series. **Materials and Methods:** Eleven patients with LAC, following uneventful phacoemulsification with CCC and in-the-bag IOL implantation were enrolled. After the basic slit lamp examination, each case was investigated with Scheimpflug photography and ultrasound biomicroscopy (UBM). Each case was treated with capsular lavage. Biochemical composition of the milky fluid was evaluated and ring of anterior capsular opacity (ACO) was examined under electron microscope. **Results:** All 11 cases presented with blurring of vision after 6-8 years of cataract surgery with IOL implantation. All cases had IOL microvacuoles, 360° anterior capsule, and anterior IOL surface touch along with ACO, ring of Soemmering, and posterior capsule distension filled with opalescent milky fluid with whitish floppy or crystalline deposits. Biochemically, the milky fluid contained protein (800 mg/dl), albumin (100 mg/dl), sugar (105 mg/dl), and calcium (0.13%) and was bacteriologically sterile. Histologically, the dissected ACO showed fibrous tissue. All cases were successfully treated with capsular lavage with good visual recovery and with no complication. There was no recurrence of LAC during 2 years postoperative follow-up in any of the cases. **Conclusions:** LAC is a late complication of standard cataract surgery. It may be a spectrum of capsular bag distension syndrome (CBDS) without shallow anterior chamber and secondary glaucoma. Capsular bag lavage is a simple and effective treatment for LAC and a safe alternative to neodymium-doped yttrium aluminum garnet (Nd-YAG) capsulotomy.

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Liquefied aftercataract (LAC) is a delayed complication, following posterior chamber in-the-bag intraocular lens (IOL) implantation and continuous curvilinear capsulorrhexis (CCC). It is characterized by normal depth of the anterior chamber and presence of grey or white substance in the space behind the IOL within the capsular bag. There is neither myopic shift of refraction nor development of any secondary glaucoma. LAC is described to be a rare complication.[1-4] However, it is not infrequent in long duration of postoperative follow-up. Pathogenesis of LAC is not fully understood.

We report 11 such cases, which were observed and finally treated by capsule bag lavage. The cases were detected between 6 and 8 years postoperative period. The purpose of the report is to describe LAC, its cause and treatment.

Materials and Methods

Ethical clearance for the study was obtained from the institutional review board according to the Declaration of Helsinki and informed consent from all patients was taken. In all the 11 cases, standard uneventful coaxial ultrasonic phacoemulsification was performed with capsulorhexis, hydrodissection, and enhanced cortical cleanup and in-the-bag hydrophobic foldable IOL fixation with anterior capsular overlap (on IOL surface). Surgeries were performed by a single experienced surgeon, with a superior clear corneal incision. But, progressive blurring of vision was detected by the patients during 6-8 years following the surgery. The blurring of vision was relatively more in the morning in two cases, when they get up from bed. Visual loss ranged from five to 15 letters in the Snellen's chart and its onset was gradual. Refraction could not be assessed due to media blur.

Slit lamp examination in all cases revealed *in situ* IOL with varying grades of microvacuoles in the IOL optics. Two IOLs had whitish hue and discoloration. All had anterior capsular opacity (ACO) limited only to the anterior capsule in touch with the IOL surface, ring of Soemmering or its remnants, and posterior capsular distension. Upper part of the distended capsular bag was filled with opalescent milky fluid and the dependent part contained whitish floppy or crystalline deposits. Along with time, there was progressive increase of distension of the posterior capsule and decrease of the deposits. The space between the IOL and the posterior capsule continued to remain filled with milky opalescent fluid, which in slit beam looked like a meniscus-shaped opaque space with concave anterior and convex posterior border. Optical section showed as if two lenses are placed in the bag, anterior one was clear and the posterior one opaque, mimicking piggybag IOL [Fig. 1a and b]. At variable interval, the posterior capsular distension became stationary. In three cases, the progressively descending fragments of ring of Soemmering behind the IOL within the capsule bag were noticed [Fig. 2]. Intraocular pressure was normal (ranging from 10 to 16 mmHg) in Goldmann applanation tonometry (GAT)

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and the angle of the anterior chamber was open up to the scleral spur on gonioscopy in all cases.

Scheimpflug photography of the anterior segment of the eye showed relative density of the milky white substance behind the IOL, ranging from 64 to 70% [Fig. 3]. Displaced posterior capsule and distended capsular bag was evident with ultrasound biomicroscopy (UBM) [Fig. 4].

Surgical technique

All cases were treated by capsular bag lavage under topical anesthesia. Surgical steps comprised of making two clear corneal incisions (2 and 2.75 mm) 120° apart, where former incision was used for different maneuvers and the latter for mechanical coaxial irrigation aspiration (IA). Aspiration of 0.2 ml of milky fluid from the capsular bag with a 26 g needle inserted through the interface between the anterior capsular rim and IOL surface for biochemical and bacteriological study. A 360° separation of anterior capsule from the IOL surface by a flat instrument; followed by lifting of the IOL with the second instrument, insertion of IA tip in the capsular bag behind the IOL in continuous irrigation mode and capsular bag lavage by irrigation and aspiration. [Fig. 5], followed by removal of ACO by blunt dissection and anterior chamber reformation with balanced salt solution (BSS). Ocular viscoelastic device, sodium hyaluronate (Helon 5000 10 mg/ml, Abbott Medical Optics, CA, USA) was used freely during different maneuvers. The ACO was examined by light and transmission electron microscope (TEM). Postoperatively, topical steroid was used for 4 weeks. Cases were in follow-up for 2 consecutive postoperative years.

Results

The study enrolled 11 cases. All cases presented with painless, gradual visual loss which ranged from five to 15 letters in the Snellen's chart, 6-8 years after uneventful cataract surgery. All cases had IOL microvacoule, sealed capsular bag with 360° anterior capsule and IOL touch. There was associated ring of Soemmering and a distended capsule filled with milky opalescent fluid and whitish floppy, and crystalline deposits in the capsular bag behind the IOL. None of the cases had high intraocular pressure or shallow angles. Average chemical composition of the opalescent milky fluid was protein (800 mg/dl), albumin (100 mg/dl), sugar (105 mg/dl),

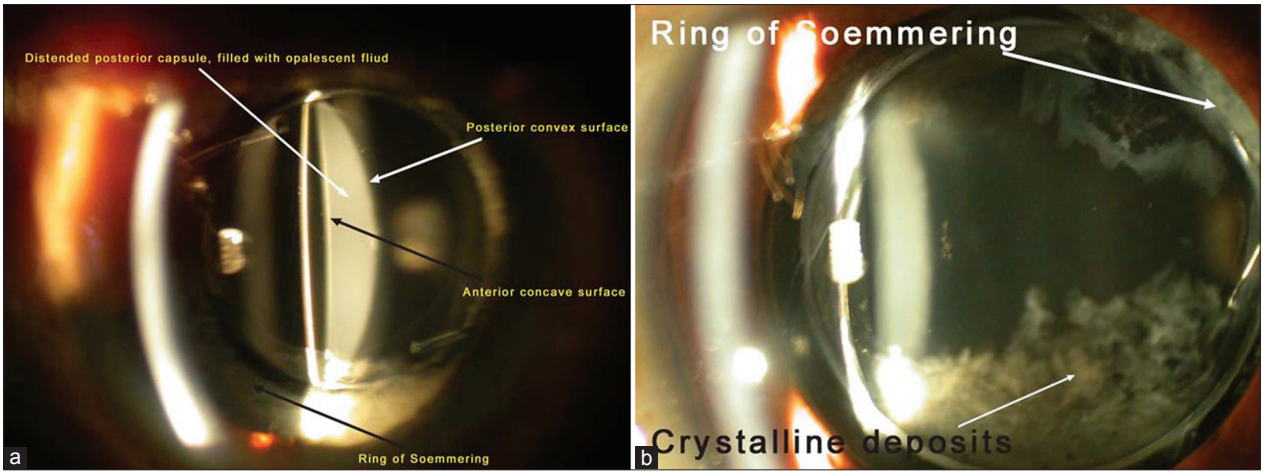

Figure 1: Slit lamp photograph: The space between posterior surface of the intraocular lens (IOL) optics and anterior surface of posterior capsule is distended with opalescent fluid in the upper and crystal in the lower part. (a) Early and (b) late

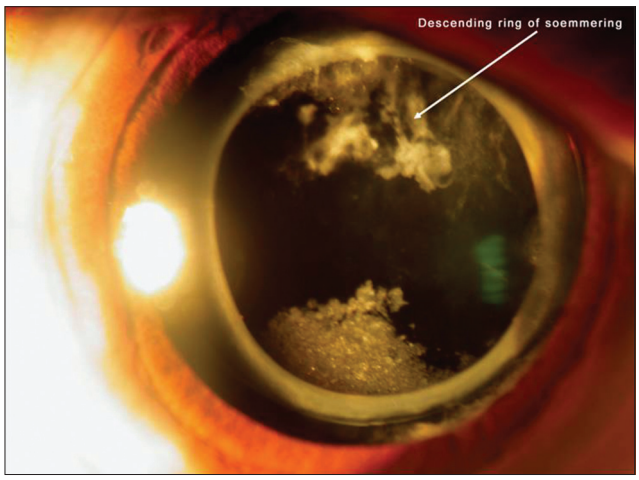

Figure 2: Slit lamp photograph: Descending ring of Soemmering in the closed capsular bag and crystalline lens material deposits). Intraocular pressure was normal (ranging from 10 to 16 mmHg)

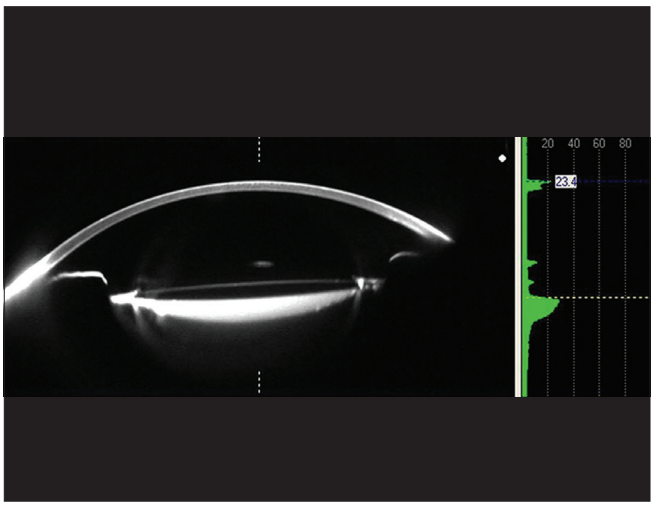

Figure 3: Scheimpl ug photography of the anterior segment of the eye showing relative density of the fluid

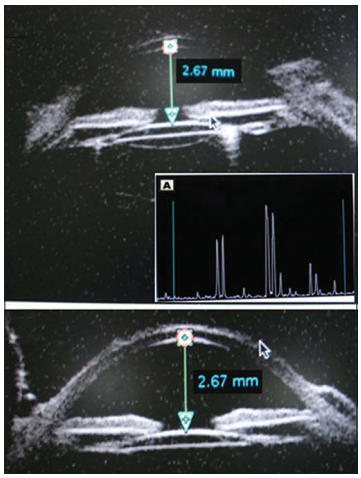

Figure 4: Ultrasound biomicroscopy (UBM) identifies posterior capsule distension. Longitudinal axial UBM echogram shows similar pre- and posttreatment anterior chamber depth (2.67 mm)

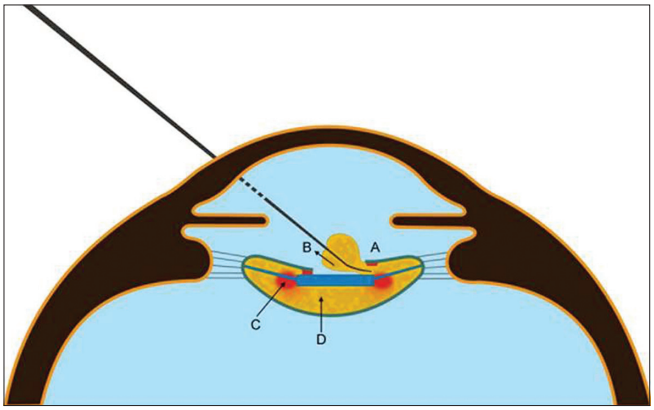

Figure 5: A = Anterior capsule detached from IOL surface, B = a gush of milky fluid escaped from the capsular bag, C = ring of Soemmering, D = opalescent fluid in the capsular bag

and calcium (0.13%) and it was bacteriologically sterile. The electron microscopy of the ACO showed fibrous tissue. In all cases, the ring of the ACO was found adhered to the anterior surface of the IOL. In fact, the distended capsular bag was found sealed. However, the adhesion could be easily separated by blunt dissection and when the IOL-ACO adhesion was released, escape of a gush of milky fluid around the CCC margin was observed. Lifting of the IOL and lavage of the capsular bag was easy and the entire capsular bag became clear after IA of the bag. On removal of the IA tip, the IOL automatically gets repositioned in the bag. No intraoperative complication was observed in any of the cases and all had uneventful postoperative recovery. There was no adhesion between the posterior capsule and the posterior surface of the IOL. Each case was followed-up for a minimum period of 2 years postoperatively and there was neither any postoperative complication nor recurrence of LAC; and posterior capsule remains in proximity to the IOL surface with 20/20 vision. The pre- and postoperative data of each patient is shown in Table 1.

Discussion

LAC is a rare condition where a milky white substance accumulates in the space between the IOL and the posterior

Table 1: The pre- and postoperative details of all the 11 cases

Years of after primary surgery for presentation as LAC	Preoperative			Postoperative
	Presenting symptoms	Vision	IOP	Vision
6	Blurring of vision	20/40	16	20/20
7	Blurring of vision	20/40	10	20/20
7	Blurring of vision	20/40	15.5	20/20
6	Blurring of vision	20/60	16	20/20
8	Blurring of vision	20/40	11	20/20
7	Blurring of vision	20/60	13	20/20
6	Blurring of vision, worse when she gets up in the morning	20/60	12	20/20
9	Blurring of vision	20/60	14	20/20
6	Blurring of vision	20/40	10.5	20/20
7	Blurring of vision	20/15	14	20/20
8	Blurring of vision	20/15	15	20/20

Intraocular pressure (IOP) of all the cases were normal (10-20 mmHg), pre- and postoperatively. All the cases had open angle in gonioscopy.
LAC: Liquefied after cataract

capsule in late postoperative period. There may be hyperopic, myopic, or no change of refraction and positive higher order aberration (spherical) with or without decrease of vision. Incidence of LAC is 0.27%, that is, three in 1,100 cases.[5] Generally, the postcataract surgery follow-up gets completed by 3 months, but in real sense, LAC is not uncommon in long postoperative period. As seen in present series, all cases underwent cataract IOL surgery minimum 6 years earlier. Capsular bag distension syndrome (CBDS) may develop during surgery and early and late postoperative period. According to Miyake *et al*., LAC or Lacteocrumenasia is nothing but late postoperative CBDS, usually without high intraocular pressure or shallow anterior chamber. According to them, development of LAC occurs probably due to accumulation of proliferative residual lens cortex in the closed capsular bag, behind the IOL. This lens matter creates an osmotic gradient across the lens capsule and draws aqueous humor in the capsular bag.[1,5,6] Onset of vision loss in LAC is gradual, but acute onset vision loss was also reported.[7,8] Vision loss may be due to scattering of light by the opalescent meniscus posterior to the IOL exerting a piggy bag IOL effect.

Ring of Soemmering is a common type of secondary cataract following extracapsular cataract surgery.[9] In the present series, in all the cases, original lens capsular openings created by capsulorrhexis were found occluded due to adhesion between ACO and anterior surface of the IOL. 'A' cells of the lens epithelium form ACO and remains adhered to the IOL. Immunohistochemical study shows that this adhesion is mediated by fibronectin.[10,11] Similarly, posterior capsule is also assumed to be adhered to the posterior surface of the IOL and bioadhesive nature of the IOL may act as an additional adhesive force. Residual cortical fibers and capsular 'E' cells are trapped initially within a sealed structure created by anterior capsular

flap, posterior capsule, and edge of the IOL. In fact, the IOL edge remains sandwiched in between the two capsules. But the adhesion between bioadhesive surface of the hydrophobic acrylic IOL and posterior capsule may be doubtful as high resolution laser interferometer study demonstrated existence of a space between the IOL and posterior capsule.[12,13] So, we believe that the fragments of ring of Soemmering descend through the cleavage and accumulate in the depended part of capsular bag behind the IOL; as demonstrated by the accumulated floppy or crystalline material and presence of fragments of ring of Soemmering in that space probably due to saccadic movement of the eye. It progressively liquefies and draws fluid across the lens capsule due to osmotic gradient created by proteins liberated from the ring of Soemmering and lens epithelial cells as seen in hypermature morgagnian cataract, where the lens cortex liquefies to form milky fluid. Miyake *et al*., have the same opinion.[1,7]

So, LAC is basically a late onset postoperative CBDS without shallowing of anterior chamber (AC) and secondary glaucoma. Forward displacement of IOL is prevented by the posterior vector force exerted on the IOL by the thick ACO. Interestingly, the ACO is only limited to the area of capsular overlap on IOL surface, suggesting it may be an interaction between 'A' cells of lens capsule and IOL Biomaterial, which caused enhanced pseudofibrous metaplasia of the anterior epithelial cells ('A' cells). However, Bao *et al*., described LAC and late onset CBDS, as two different entities.[4] In the present series, the milky fluid is thought to be liquefied lens material derived out of ring of Soemmering, as its relative density was 64-70% in preoperative Schiempflug photography. Progressive disappearance of fragments of ring of Soemmering and other crystalline material in the bag and higher concentration of protein and calcium in the aspirated fluid also suggests the same. Ring of Soemmering inherently develops in all cases of extracapsular cataract surgery. In aphakic eye, visual axis is usually clear as the ring of Soemmering remains entrapped in the periphery as a sealed structure, where margin of the anterior capsular flap remains adhered to the posterior capsule by fibrous tissues. In pseudophakia, capsular ergonomics is different, where IOL stands in between anterior and posterior capsule preventing fibrous organization of anterior capsular flap and the posterior capsule as occurs in aphakia.

But, it is unclear why selectively in some cases following hydrophobic IOL implantation, the lenticular material slips behind the IOL. It may be due to inadequate cleaning of the superior subincisional cortex where its remnants gets sandwiched between the IOL and posterior capsule, and subsequently descends in that cleavage along with the ring of Soemmering; due to gravity and saccadic eye movement (all cases of the present series had superior incision) or increased pressure exerted by the regenerating lens matter causing separation of posterior capsule from IOL surface. Other individual factors may be surgery-induced disturbance of blood ocular barriers leading to free access of different molecules, growth factors, hormones, and cells in the capsular bag or deposition of various cell types inside the capsule during surgery or postoperatively and biocompatibility of IOL material.[9,14] Accumulation of similar material has been documented.[15]

Visual blur is due to opalescent fluid and piggy bag effect exerted by LAC. Visual blur associated with the postural change in two patients is thought to be because of accumulation of the material in the dependent part due to gravity.

Various treatment options including neodymium-doped yttrium aluminum garnet (Nd-YAG) capsulotomy have been described for treatment of LAC.[16,17] *Propionibacterium acnes* have been cultured in the opalescent fluid in some cases. So, Nd-YAG laser posterior capsulotomy bears a potential risk of spread of infection in such cases. But in the present series, the milky fluid was sterile in all cases. Thus, the milky fluid may accumulate in two conditions-one in LAC and the other sequestrated endophthalmitis, where causative organism is propionibacterium acne. However, propionibacterium sequestrated endophthalmitis has relatively early onset. Nd-YAG secondary posterior capsulotomy can be associated with other complications like IOL damage, cystoids macular edema, glaucoma, uveitis, retinal detachment, IOL subluxation, etc.[12] In all our cases, posterior capsule was unidentifiable by slit lamp and focusing of aiming beam on the posterior capsule was not possible. So, we decided to treat the condition by capsular bag lavage.[12,16,17]

Aspiration of fluid and lavage of the capsular bag is a technically simple, safe, and effective procedure where the posterior capsule remains intact and all the milky fluid including remnants of lens matters, and ring of Soemmering can be aspirated out. LAC does not recur up to 2 years postsurgery. Moreover, it will give an opportunity to know the bacterial status and composition of the fluid. All cases of LAC of the present series were in conjunction with ACO, ring of Soemmering, crystalline deposit in the capsular bag, and milky white fluid. The posterior capsular bag lavage was found to be a safe and effective method of management in such cases, but understanding of exact etiology and prevention of LAC will be an important option of treatment.

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