Original Article

Achieving successful capsulorhexis in intumescent white mature cataracts to prevent Argentinian flag sign - A new multifaceted approach to meet the challenge

Monika Balyan, Arun Kumar Jain, Chintan Malhotra, Jagat Ram, Deepika Dhingra

Purpose: To present a case series of intumescent white cataract cases managed by a new surgical technique to attain a single stage Continuous Curvilinear Capsulorhexis (CCC). **Methods:** The series included 60 eyes of 60 patients with white cataract which underwent preoperative anterior chamber depth, lens thickness and ultrasonographic A-scan for intralenticular spikes. A partial size main port (~1.8mm) is created as the first entry into the anterior chamber (AC). A 30-gauge needle of insulin syringe entered through a limbal stab incision is used to decompress the anterior and posterior intralenticular compartments. Following which a standard size, one stage capsulorhexis was performed in a trypan blue stained capsule using microcapsulorhexis forceps entered through the partial sized trapezoidal main port. The main port was secondarily enlarged for phacoemulsification. **Results:** Based on the intraoperative findings, 43 eyes were categorized as Intumescent type-1 cataracts i.e., with presence of actual liquefied cortex aspirated using 30-gauge needle and 17 eyes as Intumescent type-2 cataracts, i.e., presence of swollen lens without any obvious liquefied cortex. Standard size, circular and centred CCC was achieved in 100% of the cases and no Argentinean flag sign was noted. Surgeon perceived raised intralenticular pressure in 41% of the cases in type-1 subset and 61% cases in type-2 subset (P-0.06). Posterior capsular plaque was observed in 22% of the cases, adherent cortex in 25% and anterior capsular plaque in 5% of the cases. At 6weeks follow up 92% patients had best corrected visual acuity of 20/40 or better. **Conclusion:** A multi-layered approach can help in attaining successful CCC in cases of white mature cataract with high intralenticular pressure.

Access this article online
Website:
www.ijo.in
DOI:
10.4103/ijo.IJO_1903_20
Quick Response Code:

Key words: Continous curvilinear capsulorhexis, intralenticular pressure, intumescent cataract

In the modern era of phacoemulsification when cataract surgery is rapidly evolving, mature white cataract remains a challenging entity even for experienced surgeons. Attainment of a continuous curvilinear capsulorhexis (CCC) is considered to be the limiting step, particularly for the intumescent subtype. The incidence of incomplete capsulorhexis associated with white cataracts is variable and ranges from 3.85% as reported by Jacob *et al*.[1] to 28.3% by Chakraborty *et al*.[2]

Multiple factors may contribute to difficulty in attaining CCC, like the absence of red reflex, presence of a calcified, or fragile capsule.[3-6] In addition to it the intumescent subset is associated with raised intralenticular pressure (ILP), so when the anterior capsule is punctured for the creation of a rhexis, the liquified cortex egresses out and fills the anterior chamber (AC), making visibility even poorer. Moreover, the raised ILP exerts pressure on the capsule leading to its extension. The appearance of the biradial tear in a trypan blue stained capsule simulates the Argentinean flag, and the sign was named “The Argentinean flag sign” by Daniel Perrone.[7] This tear can further extend to the periphery, leading to zonular rupture, posterior capsular rupture, nucleus drop, and intraocular lens (IOL) dislocation. The nucleus of variable hardness remains concealed behind the opacified cortex and the absence of a protective epinuclear cushion renders the posterior capsule prone to rupture while performing phacoemulsification.[8,9]

No standard definition for the intumescent subset is given in the literature. Centurion *et al*. described the intumescent subtype as a cataract thicker than 5.5 mm with an AC angle smaller than 45° and anterior chamber depth (ACD) less than or equal to 2.2 mm.[10] While Brazitikos *et al.* defined it as a cataract with a flocculent cortex and high internal reflections on ultrasound A-scan.[11]

Although staining of the anterior capsule and aspiration of the liquified cortex is routinely performed by the surgeons during white cataract surgeries, we describe a technique in which the same is performed in a pressure equalized, functionally closed AC attained by creating a sub 2 mm main

Cataract and Refractive Services, Advanced Eye Centre PGIMER, Chandigarh, India

Correspondence to: Dr. Arun Kumar Jain, Department of Ophthalmology, Room No 110 Advanced Eye Centre, Post Graduate Institute of Medical Education 2nd Research, Sector 12, Chandigarh - 160 012, India. E-mail: aronkjain@yahoo.com

Received: 19-Jun-2020 Revision: 10-Sep-2020
Accepted: 21-Dec-2020 Published: 21-May-2021

Cite this article as: Balyan M, Jain AK, Malhotra C, Ram J, Dhingra D. Achieving successful capsulorhexis in intumescent white mature cataracts to prevent Argentinian flag sign - A new multifaceted approach to meet the challenge. Indian J Ophthalmol 2021;69:1398-403.

port incision. A 30 Gauge needle that is used for cortical matter aspiration is used to release the equatorial block and the posterior ILP as well.

Methods

This study included 60 eyes of 60 patients with white intumescent cataracts. The exclusion criteria were a history of serious coexisting ocular disease (e.g., pseudoexfoliation syndrome, uncontrolled glaucoma, ocular tumors, and trauma). The study was approved by the local ethics committee of the participating center. All patients were informed about the purpose of the study and provided their consent.

The preoperative ocular examination included the Snellen visual acuity, slit-lamp biomicroscopy, ultrasonography (USG) B scan to evaluate the status of the posterior segment. Pupils were dilated using tropicamide (0.8%), phenylephrine hydrochloride (5%) drops, for cataract evaluation under dilatation. Axial length, ACD, lens thickness (LT), Keratometry were performed using IOL Master (Carl Zeiss, Meditech) and the intralenticular spikes were recorded on the USG A-scan (AL-100 TOMEY GmbH, Germany).

White cataract cases presumed to be of intumescent subtype were included in the study. The other subtypes like white pearly cataracts associated with the solid cortex, morgagnian cataracts, white cataracts with calcified or fibrosed anterior capsule were eliminated from the study. The preoperative clues for the intumescent subtypes were (i) On slit-lamp biomicroscopy these cases had the presence of a shallow AC, presence of fluid vacuoles or sectoral markings in the anterior cortex [Fig. 1a], (ii) On USG A-scan white cataracts showing the presence of multiple internal acoustic reflections were categorized as the intumescent subtype, where the multiple spikes indicated multiple fluid compartments [Fig. 1b]. On the other hand, the cases which showed a few internal acoustic reflections on USG A-scan [Fig. 1c] and no slit-lamp findings indicative of the intumescent subset were excluded from the study. With the recent introduction of newer Swept-source-based optical coherence tomography (SS-OCT) devices such as CASIA 2 (Tomey, Nagoya, Japan) the full thickness scanning of the lens has become possible. The intralenticular fluid pockets can be viewed preoperatively and help in differentiating the intumescent subtypes from the other subsets of white mature cataracts [Fig. 1d]. However, this modality was introduced later on as a part of the assessment, therefore the related findings were not included in the study.

Surgical technique: All surgeries were performed by the same surgeon under topical/peribulbar anesthesia, maintaining aseptic precautions. A preoperative hyperosmolar agent was not used for any of the cases. A partial width main port incision is made with a 2.2 mm keratome (Alcon Laboratories, Fort Worth, Texas), which is entered at the endothelium halfway

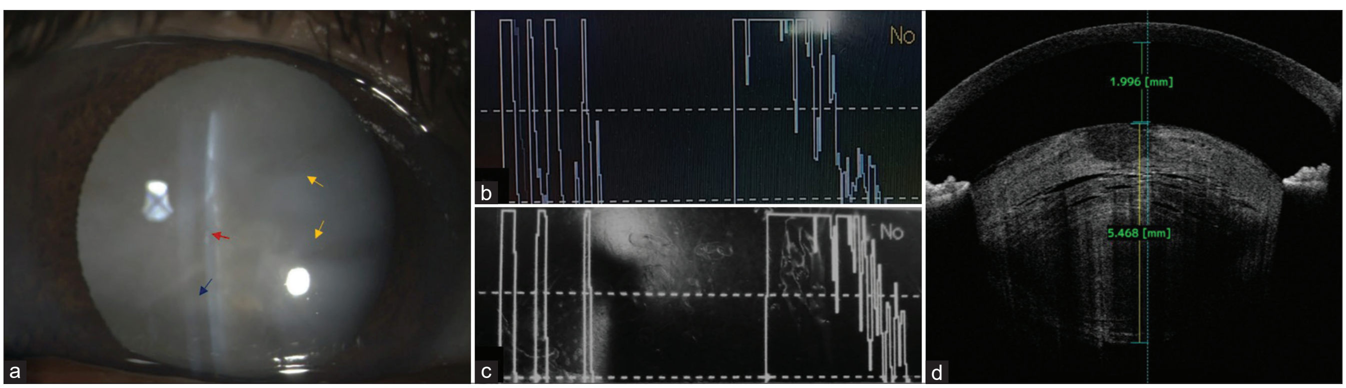

Figure 1: (a) An intumescent cataract with shallow anterior chamber (blue arrow), with translucent sectoral markings in the cortex (yellow arrows) and presence of a translucent fluid-filled area between the anterior lens capsule and the lens fibers (red arrow) (b) USG A-Scan of the eye in figure a, showing multiple intralenticular spikes (c) A pearly white cataract showing few intralenticular spikes on USG A-Scan (d) SS-OCT of the eye described in figure a and b, showing shallow anterior chamber with anteriorly bulging, swollen lens and multiple hypoechoic areas indicating cortical fluid clefts

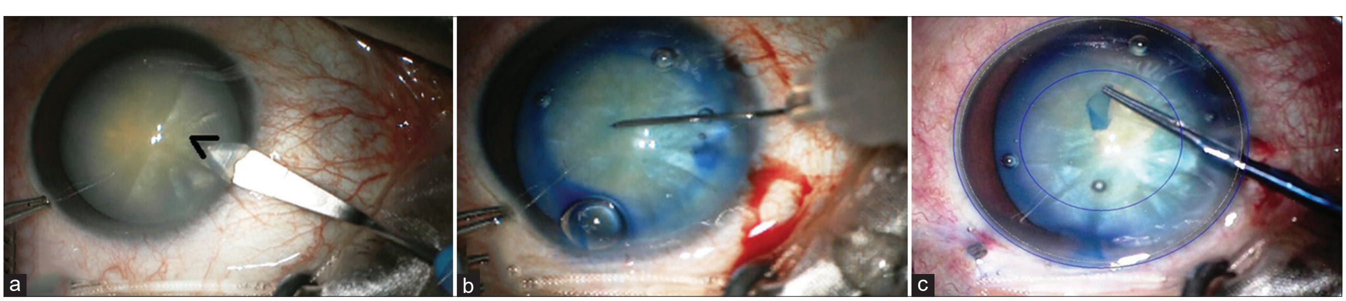

Figure 2: (a) Intraoperative picture showing the creation of a trapezoidal main incision by entering only halfway through the length of the bevelled tip of a 2.2 mm keratome (black mark), (b) Showing the use of a 30- gauge needle inserted through limbal stab incision for aspiration of cortex followed by tipping the nucleus posteriorly, (c) Showing creation of a rhexis using micro-rhexis forceps through the partial size main port under CALLISTO eye capsulorhexis guide

between the tip and a mark made on it. This results in the inner lip of the trapezoidal phaco tunnel to be of a smaller size of approximately 1.2-1.4 mm [Fig. 2a], to maintain a non-leaky AC during capsulorhexis creation. An ophthalmic viscosurgical device (OVD) DisCoVisc (Alcon Laboratories, Inc., Fort Worth, TX), containing 1.6% hyaluronic acid and 4.0% chondroitin sulfate is injected into the AC. Two standard side ports of 1.2 mm size were made in a usual manner. The anterior capsule of the lens was stained with trypan blue dye 0.03% (50% dilution of 0.06% dye) (Auroblue, Aurolabs, India) under the OVD using the painting technique.[12] After capsular staining, DisCoVisc is injected again to replace the dye stained viscoelastic for enhanced visibility as well as to flatten the anterior capsule of the lens. Following this, an 8 mm long 30-gauge needle mounted over a 1 cc insulin syringe is bent near the hub, with the bevel facing down and is entered into the AC through a separate limbal stab incision to prevent any leakage from the AC. The anterior capsule is punctured in the center to aspirate the liquefied cortex and decompress the anterior intralenticular compartment [Fig. 2b]. Any cortical matter leak at this point is noted. This is followed by tipping the edge of the nucleus posteriorly with the needle tip so that the fluid trapped between the posterior surface of the nucleus and anterior surface of the posterior capsule flows anteriorly, resulting in decompression of the posterior intralenticular compartment as well. As much fluid as possible is then aspirated. The OVD is injected again to compensate for the loss of intralenticular volume & to flatten the anterior capsule into a flat/scaphoid configuration. The OVD injected is from the periphery in a centripetal and circumferential manner so the fluid trapped in the periphery under the capsule egresses out from the center. A CCC is then completed in a single stage using a micro-capsulorhexis forceps (Haldipurkar-Masket Capsulorhexis forceps, Plus Surgicals, Kolkata) under the guidance of Callisto assisted capsulorhexis system (Carl Zeiss Meditec AG, Jena, Germany) where the outer circle is set at 5.3 mm and inner circle at 5.1 mm to attain a CCC of approximately 5 mm size at the IOL plane [Fig. 2c]. While creating capsulorhexis surgeon made a note of his perception of the raised ILP in terms of the tendency of the lens to bulge anteriorly making AC shallow, the need for injecting viscoelastic repeatedly to keep the AC formed, and the tendency of the rhexis towards the periphery. The main incision is then entered fully with the 2.2 mm keratome, and phacoemulsification is completed in a usual manner.

Data were analyzed using the Statistical Program for Social Sciences (SPSS), version 10.0, and Statistics version 5.1/97. The statistical analysis was performed using Fisher's test. Results were expressed as means ± SD. A P value of less than 0.05 was considered statistically significant.

Results

Intumescent cataracts that were included in the study were divided into two subtypes, according to their intraoperative findings**.** ***Intumescent type 1***-with liquified cortex and ***intumescent type-2*** with no cortical matter liquification. While all the cases had the presence of a swollen lens with high ILP, the cases categorized as type 1 had the presence of a liquified cortex amenable to aspiration with a 30-gauge needle, with or without the presence of cortical matter leak into the AC. The cases categorized as type-2 had the presence of raised ILP without the presence of obvious liquification of the cortex. The lens fibers in this variety are hydrated and swollen leading to raised ILP. Due to the absence of liquified cortical material, there is an absence of any cortical leak on puncturing the capsule, and a dry tap is obtained in an attempt to aspirate the cortex. These cases with raised ILP and non-amenable to decompression have the highest tendency of runaway rhexis, as perceived by the surgeon as a higher grade of difficulty in attaining rhexis. Of the 60 eyes operated 43 were characterized into intumescent type 1 and 17 eyes intumescent type 2.

The overall mean LT and mean ACD was 4.20 ± 0.73 mm and 2.60 ± 0.40 mm. The mean LT in type 1 and 2 subset was 4.05 ± 0.52 mm and 4.20 ± 0.67 mm (P-0.85) and the mean ACD was 2.71 ± 0.54 and 2.69 ± 0.60 (P-0.19) respectively. 73.2% of the cases of intumescent subtype had the presence of high intralenticular spikes on preoperative A-scan (P-0.006).

Flag sign was not noted in any of the cases. A single-stage, circular, and a well-centered CCC was achieved in 100% cases, with implantation of IOL in the bag. The overall mean rhexis size obtained was 5.07 ± 0.29 mm. A mean rhexis size of 5.01 ± 0.69 mm was noted in the type 1 subset and 5.14 ± 0.39 mm in type 2 subset respectively (P-0.13).

The surgeon perceived raised ILP in (17/43) 41% of the cases in the type-1 subset and (11/17) 61% cases in the type-2 subset (P-0.06). Grade of difficulty in achieving a CCC in terms of ease of completing the rhexis in one go, feeling of runaway of rhexis towards the periphery [Table 1] was greater in the type 2 subset, where 91% (39/43) of type-1 cases had a grade of difficulty of grade 1, whereas 60% (10/17) of type-2 cases had difficulty grade 1 (P-0.012). 40% (7/17) of cases in the type 2 subset had difficulty grade 2 or more as compared to 9% (4/43) cases in type 1 subset (P-0.03). A posterior capsular

Table 1: Showing grading of the difficulty in attaining capsulorhexis as perceived by the surgeon intraoperatively

Grade of difficulty	Observation
Grade 1	Rhexis completed in one go, using single entry through the main port only. No tendency of rhexis to run towards periphery. No need of reinjecting viscoelastic in between starting and finishing the rhexis.
Grade 2	Rhexis completed in multiple steps by switching between main and side port. Some tendency of rhexis to go towards periphery.
Grade 3	Rhexis completed in multiple steps by switching through the ports multiple times, need for repeated injection of viscoelastic to keep AC formed, use of other instruments (e.g., scissors) to cut the extending edge. High tendency of rhexis to go towards periphery.
Grade 4	Rhexis extension/uniaxial tear/flag sign.

plaque was observed in 22% of the cases and anterior capsular plaque in 5% of the cases [Fig. 3a]. Cortex which does not come out in form of a sheet instead comes in small flakes giving a feel of adherent/flaky cortex and appear similar to clustered 'fish eggs' deposited on the posterior capsule [Fig. 3b] was observed in 35% cases. Meticulous polishing of the posterior capsule was required to remove this type of flaky cortex. At 6 weeks follow up 92% of patients had best-corrected visual acuity of 20/40 or better.

Discussion

In this study, the flag sign was not encountered in any of the cases. The concept of the presence of pressurized intralenticular compartments, which was initially put forth by Figuerado *et al.*[13] was advocated in the technique described here. In the presence of two pressurized intralenticular compartments, anterior and posterior to the nucleus [Fig. 4a], when the anterior capsule is punctured, the anterior ILP is released and it becomes equal to the pressure in the AC. The unopposed high posterior ILP, held in place by an equatorial block then results in anterior bulging of the nucleus and therefore extension of the rhexis [Fig. 4b]. The technique described here to attain single-stage CCC tackles these vector forces and can be summed up under 3C's.

C1 Capsular staining using a dye under the viscoelastic cover instead of an air bubble
C2 Chamber maintenance
C3 Channelizing the Intra Lenticular Pressure (anterior as well as posterior ILP).

C1: In 1993, Hoffer and McFarland first reported using a biocompatible dye (fluorescein) to stain the anterior capsule.[14,15] We used Trypan blue 0.03% under the cover of DisCoVisc by painting technique. Staining performed under viscous dispersive viscoelastic helps in keeping the AC pressurized and maintained, along with coating and protecting the endothelium. This negates the risk of sudden shallowing of the AC and pupillary miosis due to sudden loss of the air bubble. Usage of capsular dyes not only aids in visualization of the capsule in absence of the red reflex but also helps in identifying the edge of the rhexis in case of a cortical leak or during rhexis runaway.

C2: Chamber maintenance is of paramount importance as pressure anterior to the capsule must be higher than the pressure behind it at any step to prevent the lens from bulging anteriorly. This is ensured by two factors; one is repeated filling of the AC by the copious amount of OVD and by preventing this viscoelastic to leak outside the AC by creating

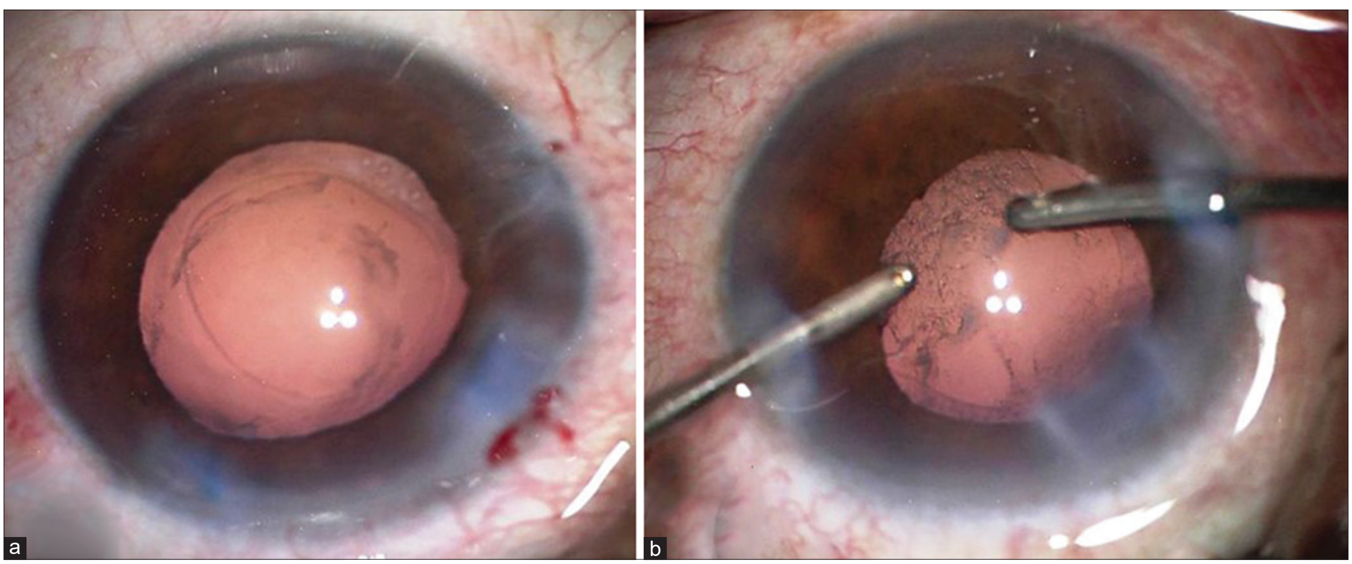

Figure 3: (a) Anterior segment photograph showing anterior and posterior capsular plaque, (b) Intraoperative picture showing flaky/fish roe cortex

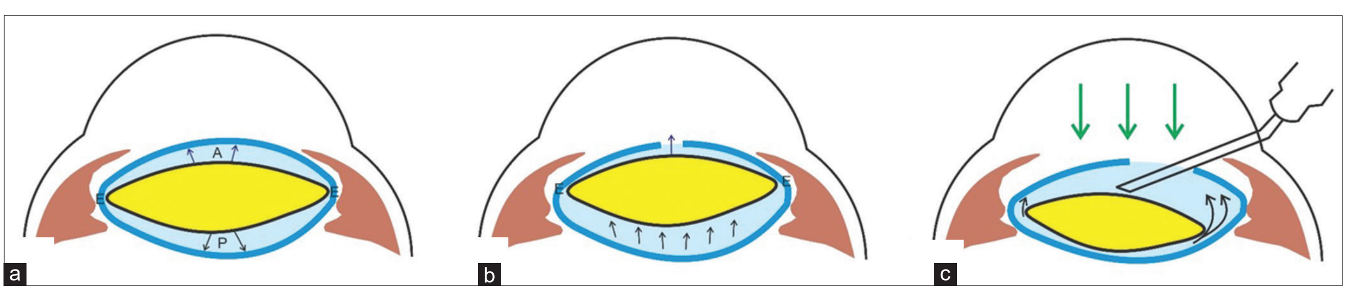

Figure 4: (a) The pressurised anterior (a) & posterior (P) intralenticular compartments (ILC). Equatorial block (E) prevents pressure exchange between the two ILC, (b) Puncturing the anterior capsule releases the anterior ILP, the unobstructed posterior ILP causes nucleus to bulge anteriorly. If this force is not over countered by OVD in the AC, the Flag sign occurs (c) A 30G needle inserted through a limbal stab incision used for cortical matter aspiration and tipping the nucleus posteriorly to release posterior ILP and equatorial block. Green arrows showing counterpressure exerted by the OVD

a functionally closed chamber. The AC is filled with cohesive dispersive viscoelastic till no more can be injected, or it started leaking from the side ports causing flattened configuration of the convex anterior capsule. Care has to be taken as not to overfill the AC with the OVD to prevent the likelihood of encountering the 'Reverse Argentinian flag sign' recently described by Bhardwaj *et al*.[16] The trapezoidal partial size main port used for rhexis creation, which is snuggly sealed by micro rhexis forceps and using a separate stab wound for cortex aspiration instead of the corneal incisions ensures that the AC remains functionally closed. Earlier, the concept of the sealed AC was employed by Chan *et al*.,[17] they attained successful capsulorhexis in all 99 eyes using a 26-gauge needle entered through a partial depth paracentesis. Recently Robinson *et al*.[18] described a technique where they used a single side-port incision of 0.8 mm size to create a single-stage capsulorhexis with 23/25-gauge microcapsulorhexis forceps which snugly fits into the incision and hence prevents OVD leak.

C3: As mentioned earlier, after the anterior capsule is punctured, the sudden unregulated decompression of the anterior intralenticular compartment associated with the unopposed posterior ILP is responsible for the runaway of the rhexis. We use a 30-gauge needle for cortical matter aspiration, which releases the anterior ILP in a controlled manner and prevents the cortical matter leakage in the AC. Tipping the nucleus posteriorly with the same needle breaks the equatorial barrier and channelize the fluid from behind the nucleus to AC, thus releasing the posterior ILP in a controlled way [Fig. 4c]. Injecting more OVD after aspiration of intralenticular fluid further flattens the convex anterior capsular configuration into lesser convex, flat, or scaphoid configuration depending upon the amount of fluid aspirated. Many authors have used different techniques for lens matter decompression. In the 'Brazilian technique' described by Figuerado *et al*., they made use of the irrigation aspiration cannula for lens matter decompression and completed the rhexis in two stages.[13] Another technique 'phacocapsulotomy' described by Mahalingam& Sambhav,[19] in which they use the phaco tip to puncture the anterior capsule and debulk the lens matter. However, in the above-mentioned techniques, it might be difficult to immediately catch hold of the rhexis edge or redirect it if a sudden runaway of the rhexis occurs.

The choice of OVD plays a significant role while operating intumescent cataracts. Studies recommend the use of high viscosity cohesive OVDs to pressurize the AC so that the pressure in front of the capsule remains more than the pressure behind it. The 'Capsular milking technique" described by Soon-Phaik Chee[20] advocates the creation of a partial entry main incision and a viscoadaptive OVD, Healon 5 (2.3% sodium hyaluronate) is used to flatten the center and mid-periphery of the lens where CCC can be safely initiated after cortical matter aspiration. The use of preoperative intravenous mannitol is done for all the cases, to decrease the vitreous pressure; however, the technique does not take into account the role of posterior ILP. Fritz *et al*.[21] in their technique advocates using two different OVDs, i.e., placing 2.3% sodium hyaluronate centrally and 1% sodium hyaluronate at the periphery for better indentation of the lens capsule and lesser risk of rhexis enlargement than using a single viscoelastic (1% sodium hyaluronate) alone. The viscoelastic used in our study is DisCoVisc, classified under higher viscosity dispersives according to modified Arshinoff and Jafari classification of OVDs,[22] which has both viscous and dispersive properties. It provides excellent tissue protection, maintains space well, and is easy to remove.[23,24]

Another technique described for attaining capsulorhexis in white cataract is the two-stage capsulorhexis approach, originally described by Gimbel[3] in 2003, which later was advocated by Kara junior *et al*.[25] in their study. They did not encounter anterior capsular tear in any of the cases using the two-stage technique while an anterior capsular tear was reported in 23.07% cases using the single-stage technique. However, this approach is complex and increases surgical time and effort. Hengerer *et al*.[26] studied the safety of capsulotomy using femtosecond laser-assisted capsulotomy in eyes with intumescent white cataracts, they encountered radial tear in 8% of the eyes and tongue like capsular adhesions in 36% cases. These capsular adhesions are attributed to the occurrence of a cortical leak in the AC. Recently, new thermal capsulotomy devices have been introduced like the nano pulse capsulotomy (Zepto, Mynosys Cellular Devices, Inc.) which uses a nitinol ring, and Capsulaser (Excel-Lens, Inc.). However, insufficient data about their efficacy in cases of white cataract, availability and add on cost to the procedure remains an issue.

We believe that the approach described here confronts all the vector forces acting on the capsule in cases of white intumescent cataracts, causing its extension. The decompression of the anterior as well as the posterior intralenticular compartments is performed in one go while keeping the AC functionally closed. This has an advantage over the previously described techniques which use bulky instruments for the lens decompression, making AC prone to sudden collapse or nucleus to tumble abruptly**.** The CCC is performed through a trapezoidal main incision, and the sub incisional area which is difficult to be reached through the main incision can be accessed through the side port in a much more ergonomically safe manner to complete the rhexis in difficult situations.

The use of preoperative intravenous mannitol to reduce posterior vitreous pressure has been debated by many authors. There are no shreds of evidence to support its role in intumescent cataracts, and its use is mainly based on the surgeon's choice. Centered on our experience we support the concept described by Figuerado *et al*., that raised retro-nuclear pressure and not the retro-lenticular pressure is responsible for runaway rhexis.[13] Further comparative studies can be done to see its actual utility.

As the success of the current technique has been tested in the hands of a single expert surgeon, its success in the hands of surgeons with different levels of expertise needs to be evaluated. Secondly, some of the factors described in the study like, 'the grading of difficulty in achieving a rhexis and perception of raised ILP' are subjective parameters based on the surgeon's perception and can be a source of bias.

A white cataract is not a homogenous group, and it is imperative to be aware of the various presentations, as the vector dynamics and complications vary markedly amongst the subsets. However, once an adequate capsulorhexis is achieved in these cases, the difficulty of the remaining surgical procedure depends on the hardness of the lens nucleus like any other form of cataract.

Conclusion

Our study amply demonstrates that a multi-faceted approach can help in attaining a successful CCC in cases of white mature cataract with high intralenticular pressure.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Jacob S, Agarwal A, Agarwal A, Agarwal S, Chowdhary S, Chowdhary R, *et al*. Trypan blue as an adjunct for safe phacoemulsification in eyes with white cataract. J Cataract Refract Surg 2002;28:1819-25.
2. Chakrabarti A, Singh S, Krishnadas R. Phacoemulsification in eyes with white cataract. J Cataract Refract Surg 2000;26:1041-7.
3. Gimbel HV, Willerscheidt AB. What to do with limited view: The intumescent cataract. J Cataract Refract Surg 1993;19:657-61.
4. Mansour AM. Anterior capsulorhexis in hypermature cataracts [letter]. J Cataract Refract Surg 1993;19:116-7.
5. Vajpayee RB, Angra SK, Honavar SG, Katoch S, Prasad N, Bansal A, *et al*. Capsulotomy for phacoemulsification in hypermature cataracts. J Cataract Refract Surg 1995;21:612-5.
6. Vajpayee RB, Bansal A, Sharma N, Dada T, Dada VK. Phacoemulsification of white hypermature cataract. J Cataract Refract Surg 1999;25:1157-60.
7. Perrone DM. Argentinean flag sign is the most common complication for intumescent cataracts. Ocular Surgery News US Edition Dec 2000.
8. Assia EI, Apple DJ, Barden A, Tsai JC, Castaneda VE, Hoggatt JS. An experimental study comparing various anterior capsulectomy techniques. Arch Ophthalmol 1991;109:642-7.
9. Pandey SK, Werner L, Escobar-Gomez M, Roig-Melo EA, Apple DJ. Dye-enhanced cataract surgery. Part 1: Anterior capsule staining for capsulorhexis in advanced/white cataract. J Cataract Refract Surg 2000;26:1052-9.
10. Centurion V, Leal EB, Lacava AC. O exame de imagem do segment anterior no diagnostico de certeza da catarata branca intumescente [Image test in the sure diagnosis of intumescent white cataract]. Rev Bras Oftalmol 2008;67:236-42.
11. Brazitikos PD, Tsinopoulos IT, Papadopoulos NT, Fotiadis K, Stangos NT. Ultrasonographic classification and phacoemulsification of white senile cataracts. Ophthalmology 1999;106:2178-83.
12. Khokhar S, Pangtey MS, Panda A, Sethi HS. Painting technique for staining the anterior lens capsule. J Cataract Refract Surg 2003;29:435-6.
13. Figueiredo CG, Figueiredio J, Figueiredo GB. Brazilian technique for prevention of the Argentinian flag sign in white cataract. J Cataract Refract Surg 2012;38:1531-6.
14. Hoffer KJ, McFarland JE. Intracameral subcapsular fluorescein staining for improved visualization during capsulorhexis in mature cataracts. J Cataract Refract Surg 1993;19:566.
15. Burkhard Dick H, Aliyeva SE, Hengerer F. Effect of trypan blue on the elasticity of the human anterior lens capsule. J Cataract Refract Surg 2008;34:1367-73.
16. Bhardwaj S, Bottini A, Ahmed IIK, Modi YS. Reverse Argentinean flag sign: Intraoperative complication during capsulorhexis. J Cataract Refract Surg 2018;44:243-4.
17. Chan DD, Ng AC, Leung CK, Tse RK. Continuous curvilinear capsulorhexis in intumescent hypermature cataract with liquefied cortex. J Cataract Refract Surg 2003;29:431-4.
18. Robinson MS, Olson RJ. Simple approach to prevent capsule tear-out during capsulorrhexis creation in hypermature cataracts. J Cataract Refract Surg 2015;41:1353-5.
19. Mahalingam, Sambhav. Phacocapsulotomy in intumescent cataract. Nepal J Ophthalmol 2014;6:242-3.
20. Chee SP, Chan NS. Capsule milking: Modification of capsulorhexis technique for intumescent cataract. J Cataract Refract Surg 2017;43:585-9.
21. Hengerer FH, Dick HB, Kohnen T, Conrad-Hengerer I. Assessment of intraoperative complications in intumescent cataract surgery using 2 ophthalmic viscosurgical devices and trypan blue staining. J Cataract Refract Surg 2015;41:714-8.
22. Arshinoff SA, Jafari M. New classification of ophthalmic viscosurgical devices. J Cataract Refract Surg 2005;31:2167-71.
23. Petroll WM, Jafari M, Lane SS, Jester JV, Cavanagh HD. Quantitative assessment of ophthalmic viscosurgical device retention using *in vivo* confocal microscopy. J Cataract Refract Surg 2005;31:2363-8.
24. Bissen-Miyajima H. *In vitro* behavior of ophthalmic viscosurgical devices during phacoemulsification. J Cataract Refract Surg 2006;32:1026-31.
25. Kara-Junior N, de Santhiago MR, Kawakami A, Carricondo P, Hida WT. Mini-rhexis for white intumescent cataracts. Clinics 2009;64:309-12.
26. Hengere C, Hengerer FH, Joachim SC, Schultz T, Dick HB. Femtosecond laser assisted cataract surgery in intumescent white cataracts. J Cataract Refract Surg 2014;40:44-50.