International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

# A Safe and Successful Capsulorhexis Technique for the Intumescent Cataracts; Modified Two-Stage Continuous Curvilinear Capsulorhexis

**Gaurav Brahmbhatt[1], Dr. Jigeesh Desai[2]**

GMERS Medical College Gandhinagar, Gujarat, India

**Abstract:** ***Background: Intumescent cataracts present unique challenges during capsulorhexis, primarily because abrupt decompression can lead to rapid radial extension of the capsular tear. This study presents a modified two-stage capsulorhexis approach aimed at improving tear control and minimizing intraoperative complications. Materials and methods: A two-step capsulorhexis approach was utilized. Initially, a limited central rhexis of approximately 1.5–2 mm was created to permit controlled release of intralenticular fluid. Milky cortical material was aspirated through a 25-gauge cannula to normalize the pressure gradient between the lens capsule and the anterior chamber. Following adequate decompression, the capsular opening was progressively expanded to a diameter of 5–6 mm to facilitate stable nucleus management and safe phacoemulsification. The study was conducted between May 2024 and October 2024. Results: This case series comprised 40 consecutive eyes with intumescent cataract, including 22 male and 18 female patients. The mean age of the cohort was 66 ± 8 years, with ages ranging from 53 to 84 years. A complete, well-centered continuous curvilinear capsulorhexis of approximately 5–6 mm was successfully obtained in 39 eyes, corresponding to a success rate of 97.5%. One eye exhibited peripheral extension of the capsular tear during the second-stage enlargement. The extension was controlled by trimming the affected capsular edge with Vannas scissors, permitting completion of the procedure without further complication. All eyes underwent successful in-the-bag intraocular lens implantation. Conclusions: This staged approach provides improved control over capsular tear propagation when compared with a conventional single-stage capsulorhexis. Adoption of this technique may enhance intraoperative safety and predictability during phacoemulsification in eyes with intumescent cataract.***

**Keywords:** Capsulorhexis, Intumescent cataract, Phacoemulsification, Cataract surgery, Anterior capsule

## 1. Introduction

Relevant decompression and staged capsulorhexis techniques have been previously reported in the literature [1–13].

Intumescent cataract represents one of the most technically demanding situations in cataract surgery, irrespective of the surgeon's level of experience. Progressive cortical liquefaction within the lens leads to elevated intralenticular pressure, creating an unstable biomechanical environment for anterior capsule manipulation. Under these conditions, capsulorhexis becomes the most critical step of the procedure, as uncontrolled tear propagation may occur immediately after capsular puncture.

The sudden release of pressurized liquefied cortex can generate outward radial forces on the anterior capsule, predisposing to rapid peripheral extension of the capsular tear. To counteract this effect, it is essential to establish and maintain adequate anterior chamber stability prior to initiating the capsulotomy. Elevating intra-chamber pressure using cohesive ophthalmic viscoelastic devices, infusion cannulas, or chamber maintainers helps oppose intralenticular pressure and reduces capsular tension, thereby improving control of the tear vector.

Following adequate chamber stabilization, creation of a small initial capsular opening allows gradual decompression of the lens and minimizes the likelihood of abrupt tear extension. In contrast, premature capsular puncture without sufficient tamponade may result in the immediate development of the Argentinian flag sign [6,11,13], even before cortical aspiration can be initiated. In highly swollen lenses, rapid flap mobilization and controlled redirection of vector forces are necessary to regain capsular control.

Several adjunctive methods, including phaco-assisted capsulotomy [5] and vacuum assisted decompression [9] techniques, have been described to enhance safety in these challenging cases. Visualization of the anterior capsule is commonly improved using trypan blue staining; however, increased capsular stiffness following dye exposure may also influence tear behavior and potentially facilitate peripheral extension. If capsular runout occurs, the risk of serious intraoperative complications such as posterior capsule rupture, vitreous loss, nucleus drop, and unstable intraocular lens positioning increases significantly.

Multiple strategies have been reported in the literature to minimize these risks and optimize surgical outcomes in intumescent cataracts. Among them, the staged continuous curvilinear capsulorhexis technique [6,11,12] has gained attention, wherein a small initial capsular opening permits controlled decompression, followed by enlargement to a standard diameter once pressure equilibrium is achieved. In the present study, we describe a modified version of this staged approach aimed at enhancing capsular stability and improving intraoperative safety in eyes with intumescent cataract.

Materials and methods This retrospective observational study was conducted at the Department of Ophthalmology, GMERS Medical College, Gandhinagar, between May 2024 and October 2024. The study adhered to the principles outlined in the Declaration of Helsinki. Patient confidentiality was strictly maintained, and all clinical data were anonymized prior to analysis. Written informed consent was obtained from

all participants for the use of their clinical information for academic and research purposes.

Medical records of 40 consecutive patients who underwent cataract surgery using a modified two-stage continuous curvilinear capsulorhexis technique for intumescent cataract were reviewed and analyzed. Patients with a clinical diagnosis of intumescent cataract were included in the study. Exclusion criteria comprised traumatic cataract, lens subluxation, non-intumescent cataract types, previous intraocular surgery, and associated posterior segment pathology such as retinal detachment or advanced vitreoretinal disease.

All patients underwent comprehensive preoperative ophthalmic evaluation, including best corrected visual acuity measurement using a Snellen chart, intraocular pressure assessment with non-contact tonometry, slit-lamp biomicroscopic examination of the anterior segment, and posterior segment evaluation using ocular B-scan ultrasonography when fundus visualization was not possible.

The diagnosis of intumescent cataract was based on clinical evidence of lens swelling and reduced anterior chamber depth compared with the fellow eye, supported by ultrasonographic findings. Biometric parameters, including anterior chamber depth and lens thickness, were obtained using A-scan ultrasonography. Increased internal acoustic reflectivity on A-scan imaging was considered indicative of cortical liquefaction and elevated intralenticular pressure.

All surgical procedures were performed using a standardized operative protocol by experienced cataract surgeons. Intraoperative findings, capsulorhexis completion rate, complications, and immediate surgical outcomes were recorded and analyzed.

## 2. Surgical Technique

All surgical procedures were performed under topical anesthesia by an experienced cataract surgeon. No hyperosmotic agents were administered preoperatively. Standard phacoemulsification through small corneal incisions was employed in all cases.

Two paracentesis ports were created for instrument access, followed by staining of the anterior capsule with trypan blue under an air bubble to enhance visualization. A cohesive ophthalmic viscoelastic device was injected to deepen and stabilize the anterior chamber. A clear corneal main incision was subsequently fashioned using a keratome.

Capsular entry and creation of the initial capsulorhexis were performed using micro-forceps rather than a cystitome to maintain better control and avoid sudden decompression. A small central capsular opening measuring approximately 1.5–2.0 mm was carefully fashioned. The micro-forceps were maintained within the anterior chamber during this step to minimize viscoelastic egress and preserve chamber stability. When visualization was compromised by released cortical material, additional viscoelastic was injected to restore clarity before proceeding.

Liquefied cortical material was gently aspirated using a fine cannula connected to a syringe until adequate decompression of the capsular bag was achieved. Additional viscoelastic was then injected to re-establish anterior chamber depth. The capsulorhexis was subsequently enlarged in a controlled manner to a final diameter of approximately 5–6 mm using micro-forceps. When required, the capsule was carefully nicked near the initial opening using a fine needle or microscissors to facilitate controlled enlargement.

Phacoemulsification was performed using a standard stop-and-chop technique. Cortical cleanup and in-the-bag posterior chamber intraocular lens implantation were completed routinely.

Postoperative evaluations were conducted on day one, at one week, and at one month. All patients received topical antibiotic, steroid, and non-steroidal anti-inflammatory eye drops according to standard postoperative protocol.

**Statistical Analysis**

Data analysis was performed using standard statistical software. Continuous variables were summarized as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Descriptive statistics were used to analyze surgical outcomes and complication rates.

## 3. Discussion

Achieving a stable and appropriately sized continuous curvilinear capsulorhexis is a fundamental requirement for safe phacoemulsification and reliable in-the-bag intraocular lens implantation in eyes with intumescent cataract. Elevated intralenticular pressure and cortical liquefaction increase the tendency for uncontrolled tear propagation, making capsular management particularly challenging. In the present study, a modified staged capsulorhexis strategy was employed to enhance capsular stability and minimize the risk of radial extension.

The rationale for initiating the procedure with a small capsular opening lies in limiting the circumferential forces acting on the anterior capsule during the early phase of decompression. Larger initial openings may permit rapid release of pressurized cortical fluid, increasing the likelihood of peripheral tear extension. By creating a limited initial capsulorhexis and allowing gradual aspiration of liquefied cortex, intralenticular pressure can be equilibrated before enlargement to a standard rhexis diameter suitable for nucleus management.

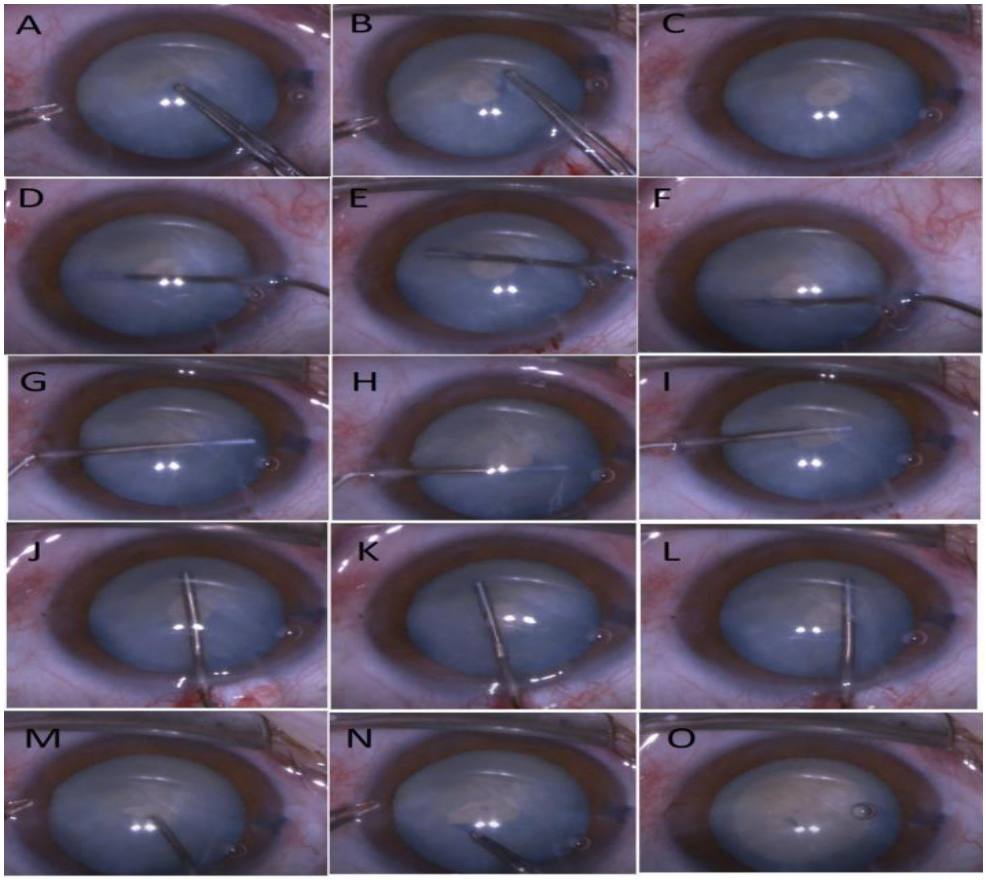


**Figure 1:** Sequential intraoperative images illustrating the modified two-stage continuous curvilinear capsulorhexis technique in an eye with intumescent cataract.

(A–C) Formation of a small central initial capsulorhexis using micro-forceps to permit controlled decompression. (D–F) Aspiration of liquefied cortical material through a fine cannula to reduce intralenticular pressure. (G–I) Stabilisation of the anterior capsule and restoration of anterior chamber depth following pressure equilibration. (J–L) Controlled enlargement of the capsulorhexis to the desired functional diameter. (M–O) Final well-centred continuous curvilinear capsulorhexis achieved prior to phacoemulsification.

Conventional single-stage capsulorhexis in intumescent cataracts has been associated with higher rates of capsular complications, prompting the development of alternative decompression strategies. Several authors have described techniques aimed at reducing capsular instability, including vacuum-assisted decompression [9], phaco capsulotomy, air tamponade [10], femtosecond laser-assisted capsulotomy [7], and staged manual approaches. Among these, the two-stage capsulorhexis method has gained attention as a practical and cost-effective approach for managing highly pressurized lenses.

Figueiredo [6] and colleagues described a staged technique utilizing a relatively larger initial capsulorhexis with bimanual irrigation–aspiration for cortical decompression. While effective, a larger initial opening may still expose the capsule to increased tearing forces during the early phase of the procedure. In contrast, the present modification employs a smaller initial capsular opening, which may reduce circumferential stress and improve control during the decompression phase.

Kara-Junior [12] et al. demonstrated a lower incidence of capsular tears in eyes undergoing staged capsulorhexis compared with a single-stage approach, although their study involved a limited sample size and did not specify the dimensions of the initial capsular opening. These findings support the principle that gradual decompression improves capsular safety, consistent with the outcomes observed in the present series.

Aspiration of liquefied cortex using a fine cannula permits targeted decompression of both central and peripheral intracapsular compartments. This approach may achieve more uniform pressure equalization compared with bimanual irrigation–aspiration alone, particularly when cortical fluid is not uniformly milky. Effective decompression results in flattening of the anterior capsule and facilitates controlled enlargement of the capsulorhexis during the second stage.

The favorable capsulorhexis completion rate observed in this study suggests that combining a small initial opening with peripheral cortical decompression may enhance surgical predictability in highly pressurized lenses. Importantly, this technique requires no specialized equipment and can be readily adopted in routine surgical practice.

The limitations of this study include its retrospective design, modest sample size, and absence of a direct control group. Prospective comparative studies may further clarify the relative advantages of different decompression strategies in intumescent cataracts.

## 4. Conclusion

The modified staged capsulorhexis technique provides a controlled and reproducible method for managing elevated intralenticular pressure in intumescent cataract. By limiting the size of the initial capsular opening and ensuring effective cortical decompression prior to rhexis enlargement, capsular stability can be significantly improved. This approach represents a
practical option for enhancing surgical safety during phacoemulsification in challenging intumescent lenses.

**Authors' Contributions**
Dr. Gaurav Brahmbhatt was responsible for study conception and design, surgical technique development, data collection, data analysis, literature review, and manuscript drafting.

Dr. Jigeesh Desai contributed to clinical supervision, study guidance, critical review of the manuscript for important intellectual content, and final approval of the submitted version.

All authors read and approved the final manuscript.

**Affiliation Format**
Department of Ophthalmology, GMERS Medical College, Gandhinagar, Gujarat, India

**Funding**
This study did not receive any external financial support or grant funding.

**Data Availability**
The datasets generated and/or analyzed during the present study can be obtained from the corresponding author upon reasonable request.

**Ethical Considerations and Consent**
This investigation was conducted as a retrospective review of anonymized clinical records in accordance with the principles of the Declaration of Helsinki. Patient confidentiality was maintained throughout the study. Written informed consent was obtained from all participants for the use of their clinical information for academic and research purposes. Formal institutional ethics committee approval was not required for this retrospective analysis as per institutional practice.

**Consent for Publication**
No identifiable patient information is included in this manuscript. Consent for publication was obtained where applicable.

**Competing Interests**
The authors declare that there are no competing financial or non-financial interests related to this study.

## References

[1] Ucar F. Spiral capsulorhexis technique with anterior chamber maintainer [1,2] under continuous fluid pressure in intumescent cataracts and its clinical outcomes. J Fr Ophthalmol. 2022;45(9):1024–1030.
[2] Chawla HB, Adams AD. Use of the anterior chamber maintainer [1,2] in anterior segment surgery. J Cataract Refract Surg. 1996;22(2):172–177.
[3] Hengerer FH, Dick HB, Kohnen T, Conrad-Hengerer I. Intraoperative complications in intumescent cataract surgery using different ophthalmic viscosurgical devices and trypan blue staining. J Cataract Refract Surg. 2015;41(4):714–718.
[4] Chee SP, Chan NS. Capsular milking: modification of capsulorhexis technique for intumescent cataract. J Cataract Refract Surg. 2017;43(5):585–589.
[5] Genç S, Guler E, Çakır H, Özertürk Y. Intraoperative complications in intumescent cataract surgery using phaco capsulotomy technique. J Cataract Refract Surg. 2016;42(8):1141–1145.
[6] Figueiredo [6] CG, Figueiredo [6] J, Figueiredo [6] GB. Brazilian technique for prevention of the Argentinian flag sign [6,11,13] in white cataract. J Cataract Refract Surg. 2012; 38: 1531–1536.
[7] Chee SP, Chan NS, Yang Y, Ti SE. Femtosecond laser-assisted cataract surgery for white cataract. Br J Ophthalmol. 2019;103(4): 544–550.
[8] Daglioglu MC, Coskun M, Ilhan O, et al. A novel capsulorhexis technique in white cataract surgery. Semin Ophthalmol. 2015; 30 (4):264–269.
[9] Kodavoor SK, Deb B, Ramamurthy D. Cannula-vacuum continuous curvilinear capsulorhexis: inexpensive technique for intumescent total cataract. J Cataract Refract Surg. 2019;45(7):899– 902.
[10] Alsmman AH, Mounir A, Sayed KM, Mostafa EM. Closed-chamber anterior capsulorhexis under air tamponade [10] in white cataract. Clin Ophthalmol. 2019; 13: 2053– 2057.
[11] Vasavada [11] A, Singh R, Desai J. Phacoemulsification of white mature cataracts. J Cataract Refract Surg. 1998;24(2):270–277.
[12] Kara-Junior [12] N, de Santhiago MR, Kawakami A, Carricondo P, Hida WT. Mini-rhexis technique for white intumescent cataracts. Clinics (Sao Paulo). 2009;64(4):309–312.
[13] Gimbel HV, Willerscheidt AB. Management of the intumescent cataract. J Cataract Refract Surg. 1993; 19: 657–661.

## Author Profile

**Dr. Gaurav Brahmbhatt,** MS Ophthalmology, Senior Resident, Department of Ophthalmology, GMERS Medical College, Gandhinagar, Gujarat, India. Corresponding Author Email: *Gauravbrahmbhatt99[at]gmail.com*

**Dr. Jigeesh Desai,** MS Ophthalmology, Professor and Head of Department, Department of Ophthalmology, GMERS Medical College, Gandhinagar, Gujarat. Email: *drjigeeshdesai[at]gmail.com*