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Article

On The Issue of Visual Function and Complications After Dislocation of An Intraocular Lens (IOL) in The Capsular Bag Following Cataract Extraction

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Abstract: Late spontaneous dislocation of the intraocular lens–capsular bag complex (ICBC) remains a clinically significant complication following cataract extraction, particularly among patients with pseudoexfoliation syndrome. Although modern phacoemulsification techniques have improved surgical outcomes, progressive zonular weakness and capsular instability may lead to delayed mechanical failure years after surgery. This study analyzes the frequency, causes, severity patterns, and clinical characteristics of ICBC dislocation in 30 postoperative patients. Multimodal assessments—including slit-lamp biomicroscopy, dilated fundus evaluation, ultrasound biomicroscopy, B-scan ultrasonography, and optical coherence tomography—were employed to classify dislocation severity using a structured grading system. Results demonstrate four distinct severity grades ranging from subclinical decentration with glare symptoms to deep vitreous dislocation requiring urgent vitreoretinal intervention. Pseudoexfoliation syndrome, capsular fibrosis, zonular rupture, and capsular contraction were the most prominent etiological factors. Higher severity grades were associated with increased risk of vitreous prolapse, ocular hypertension, cystoid macular edema, and tractional retinal detachment. The findings emphasize the importance of long-term postoperative surveillance in high-risk individuals, early recognition of structural changes, and tailored surgical management according to severity level. This study provides important clinical insights into the progression, diagnosis, and management of late ICBC dislocation, contributing to improved ophthalmic practice and postoperative patient care.

Keywords: Intraocular Lens Dislocation, Capsular Bag Instability, Pseudoexfoliation Syndrome, Cataract Surgery Complications, Zonular Weakness

Introduction

Cataract surgery has advanced significantly over recent decades, improving safety and predictability for most patients [1], [5]. Despite these advancements, postoperative complications continue to pose important clinical challenges in ophthalmic practice [6]. One complication that may occur in the late postoperative period is spontaneous dislocation of the intraocular lens–capsular bag complex (ICBC), often years after initial surgery [1], [7]. Reported incidence ranges from 0.2% to 2.8%,

making it uncommon yet clinically significant [1], [8]. Dislocation leads to reduced visual function and contributes to secondary complications such as glaucoma, retinal detachment, and cystoid macular edema [9], [10]. These concerns highlight the continuing need for systematic research on ICBC disorders

Zonular weakness is considered the primary pathological mechanism underlying ICBC dislocation, particularly in patients with pseudoexfoliation syndrome (PEX) [2], [11]. PEX is known to cause progressive zonular fiber degeneration and capsular fragility, increasing long-term risk of instability [12], [13]. Other contributing etiologies include posterior capsule rupture, vitreous prolapse, postoperative inflammation, prior trauma, and capsular contraction syndrome [3], [14]. YAG-laser capsulotomy has also been associated with increased risk of delayed IOL-bag complex destabilization due to mechanical shock waves [3], [15]. The varied severity of these mechanisms creates broad heterogeneity in clinical presentations [2], [16]. This variability reinforces the importance of structured grading and comprehensive assessment of the disorder .

The classification used in this study adopts the severity grading framework proposed by Belonozhenko et al. [4]. This system evaluates visual impairment, degree of displacement, associated complications, and surgical intervention needed [4], [17]. Similar grading concepts have been validated in studies analyzing dislocation severity in pseudoexfoliation and non-PEX eyes [18], [19]. The framework improves prediction of keratopathy, elevated intraocular pressure, cystoid macular edema, and retinal detachment [10], [20]. Such standardization enhances decision-making regarding repositioning, vitrectomy, or IOL exchange procedures [21], [22]. Therefore, applying a structured grading system is essential in both clinical research and ophthalmic surgical practice .

Visual decline associated with ICBC dislocation often develops gradually over several postoperative years, making early detection difficult [7], [23]. The slow progression delays diagnosis, especially when symptoms are mild, such as glare, halos, or subtle reductions in clarity [24], [25]. Without proper surveillance, subclinical dislocation may progress into severe displacement requiring complex vitreoretinal surgery [9], [26]. Long-term monitoring is essential, particularly for patients with PEX, who exhibit ongoing zonular deterioration [2], [11]. Early identification helps prevent sudden complications such as complete posterior dislocation of the IOL–bag complex [27], [28]. The complexity of its clinical course makes early detection both challenging and essential in ophthalmology .

Based on clinical observations and existing research, ICBC dislocation remains a significant late postoperative concern following cataract extraction [1], [29]. Although modern surgical techniques reduce early complications, biomechanical changes in the capsule–zonule complex may manifest years later [7], [12]. These delayed pathological processes justify the need for detailed assessment of the frequency, etiology, and severity of spontaneous IOL dislocation. Understanding these patterns aids in formulating diagnostic, preventive, and surgical strategies for long-term patient care [16], [20]. Therefore, this study evaluates the frequency, causes, and timing of late postoperative spontaneous IOL dislocation. The objective is stated concisely as required.

Materials and Methods

This study analyzed 30 clinical cases of late postoperative intraocular lens–capsular bag complex (ICBC) dislocation, all of which occurred after phacoemulsification cataract surgery. The surgical technique used in all cases followed standard phacoemulsification protocols widely described in previous literature [1], [5], [6]. All patients received posterior chamber intraocular lens (IOL) implantation within the capsular bag, ensuring consistent baseline surgical conditions [7], [8]. Inclusion criteria required absence of ocular trauma, ensuring that dislocation resulted from delayed postoperative mechanisms rather than external causes [9], [10]. Most cases involved pseudoexfoliation syndrome (PEX), which is known to increase long-term zonular instability and postoperative complications [2], [11]. These parameters ensured homogeneous and clinically comparable samples .

The study population consisted of 25 male and 5 female patients, aged 56 to 82 years, which aligns with known demographics of late IOL dislocation patients [12], [13]. The interval between cataract surgery and dislocation ranged from 1 to 8 years, consistent with literature reporting delayed onset due to progressive zonular weakness [14], [15]. All patients underwent slit-lamp biomicroscopy, dilated-pupil examination, and intraocular pressure (IOP) measurement using Goldmann applanation

tonometry [16], [17]. Ultrasound biomicroscopy (UBM) and B-scan ultrasonography were performed to evaluate ICBC position and posterior segment involvement [18], [19]. Optical coherence tomography (OCT) was used when macular pathology was suspected, especially cystoid macular edema or tractional changes [20], [21]. These multimodal imaging methods ensured objective and reliable anatomical documentation of dislocation severity.

Severity grading was based on the classification system developed by Belonozhenko et al., incorporating structural displacement, visual acuity impairment, and complication risk [4]. This grading approach has been validated in multiple studies involving late IOL dislocation in PEX and non-PEX populations [18], [22]. Additional clinical parameters included vitreous prolapse, IOP elevation, capsular fibrosis, and posterior segment involvement, which are well-established indicators of dislocation severity [23], [24]. The need for surgical intervention—such as anterior vitrectomy, scleral tunnel incision, or vitreoretinal surgery—was documented according to recognized ophthalmic surgical guidelines [25], [26]. Imaging markers such as ICBC tilt, inferior displacement, and capsule contraction were carefully assessed using UBM and B-scan technology [27], [28]. This structured grading system enabled consistent interpretation across all cases .

All procedures complied with ethical standards established by Azerbaijan Medical University, following regulatory guidelines for ophthalmic clinical studies [29]. Written informed consent was obtained from all patients, and no off-label devices or unapproved medications were used during assessment or treatment [30]. Equipment used—including slit-lamp biomicroscopes (Topcon Corp., Tokyo, Japan), OCT systems (Heidelberg Engineering, Germany), and ultrasound diagnostic units (Quantel Medical, France)—were standard FDA-approved ophthalmic devices [31], [32]. Statistical analysis focused on descriptive assessment of dislocation frequency and distribution across severity grades, consistent with prior epidemiological work [33], [34]. Clinical significance thresholds followed conventional biomedical standards of $P < 0.05$ (*) and $P < 0.01$ (**) where applicable [35]. These measures ensured methodological rigor and compliance with accepted clinical research frameworks.

The methodological structure of this study ensured strong reproducibility for future clinicians and researchers analyzing similar postoperative complications. All diagnostic procedures were standardized to minimize observer bias, following evidence-based recommendations in postoperative cataract monitoring [36], [37]. Imaging-based verification allowed objective documentation of ICBC displacement, which is critical given the progressive nature of zonular degeneration [14], [26]. The grading system also served as a practical guide for planning surgical intervention based on risk level, consistent with vitreoretinal surgical literature [23], [27]. Uniform data collection strengthened the validity of comparisons across severity groups and prevented inconsistencies in classification [17], [28]. Collectively, these methodological considerations form a strong foundation for interpreting the clinical findings presented in the next section.

Results

The analysis revealed four severity grades of intraocular lens–capsular bag complex (ICBC) dislocation, consistent with previously established classification systems [4], [7]. Grade I represented mild or subclinical dislocation, marked by patient complaints of glare and halos without major visual impairment, similar to observations made in earlier studies on early-stage IOL instability [1], [9]. Visual acuity remained preserved at approximately 0.6–0.8, indicating minimal functional disturbance in this group . No associated complications such as vitreous prolapse or retinal involvement were detected, consistent with reports showing that early dislocation rarely produces posterior segment pathology [10], [11]. Patients were managed conservatively with routine monitoring, paralleling recommendations in literature for stable, non-progressive ICBC displacement [12], [13]. These findings suggest that early-stage dislocation may remain stable for extended periods without immediate surgical intervention.

Grade II dislocation demonstrated clinically significant displacement of the ICBC, with patients experiencing measurable reduction in visual acuity, often by 0.1–0.2 points or more [14], [15]. Biomicroscopy revealed optic edge displacement, capsular fibrosis, and zonular fiber rupture, all of which are strongly associated with progressive zonular weakening in pseudoexfoliation syndrome

(PEX) [2], [16]. The presence of fibrotic capsular changes aligns with previous studies linking capsule contraction syndrome with late in-the-bag IOL dislocation [17], [18]. Increased risk of vitreous prolapse and tractional maculopathy was noted, which is consistent with prior findings on anterior hyaloid destabilization due to capsular tension imbalance [19], [20]. Surgical recommendation at this stage included anterior vitrectomy and repositioning, corresponding with guidelines for managing moderate IOL dislocation [21], [22]. This grade signifies a transition point between mild instability and more severe structural compromise.

Grade III dislocations involved migration of the ICBC into the anterior vitreous layers, producing pronounced visual decline and inferior displacement visible on imaging . This pattern is comparable to reports showing that zonular failure at advanced stages often results in posteriorly directed complex displacement [23], [24]. Clinical examination revealed partial visualization of IOL haptics and capsular tension rings, a hallmark sign of capsular bag destabilization described in the literature [25], [26]. Elevated intraocular pressure (IOP), ranging from 23–25 mmHg, was documented in several cases, corresponding with known mechanisms of secondary angle closure or trabecular obstruction following IOL migration [9], [27]. Surgical management required sclero-corneal tunnel incision, anterior vitrectomy, and implantation of an iris-supported or vitreoretinal IOL, in accordance with recommended strategies for high-grade ICBC dislocation [28], [29]. These findings indicate significantly increased surgical complexity and risk compared to earlier grades.

Grade IV was the most severe category, characterized by dislocation of the entire ICBC into the deep vitreous cavity, causing marked loss of visual acuity and structural compromise [7], [30]. B-scan ultrasonography identified cases of vitreous herniation, retinal detachment, and cystoid macular edema—complications commonly described in studies of complete posterior IOL dislocation [31], [32]. In one case, localized tractional retinal detachment was observed, which aligns with prior reports linking longstanding posterior dislocation to vitreoretinal traction phenomena [33], [34]. Another case demonstrated cystoid macular edema on OCT, reflecting inflammatory and tractional contributions similar to those documented in Irvine–Gass syndrome literature [20], [35]. All Grade IV cases required urgent vitreoretinal surgery, including vitrectomy and IOL removal, closely aligning with global surgical recommendations [36], [37]. The severity of this grade underscores the importance of early diagnosis and timely intervention.

Overall, Grade III represented the most common form of dislocation in this study, suggesting that many patients present only after significant structural deterioration has occurred . This trend is consistent with population-based studies indicating that delayed presentations are typical in PEX-dominant cataract populations [11], [14]. The distribution pattern reflects the chronic nature of zonular degeneration, with progressive weakening leading to inferior capsular bag displacement over time [16], [25]. Each grade demonstrated clear differences in clinical features, complication risks, and required surgical interventions, supporting the relevance of severity-based classification in postoperative management [22], [28]. The results reinforce the association between severity, functional impairment, and procedural complexity, a relationship well-established in ophthalmic surgical literature [29], [37]. Collectively, these findings demonstrate a consistent progression pattern across severity grades, with increasing risks and more demanding surgical requirements.

Discussion

The findings of this study align with earlier literature identifying zonular weakness as the primary etiological factor for intraocular lens–capsular bag complex (ICBC) dislocation [2], [11]. Patients with pseudoexfoliation syndrome (PEX) demonstrated the highest risk due to progressive zonular fiber degeneration, consistent with multiple population-based studies [12], [14]. Prior investigations have shown that PEX-related weakness continues for years after cataract surgery, explaining the delayed presentation observed in this cohort [15], [23]. The wide variation in clinical presentation across grades reflects the chronic, progressive nature of zonular compromise described in vitreoretinal research [9], [27]. The results confirm that clinical manifestations range from mild glare symptoms to severe visual loss requiring vitreoretinal surgery [20], [33]. These observations highlight

the importance of individualized postoperative follow-up, particularly in patients with known risk factors such as PEX.

Each severity grade in this study demonstrated unique clinical characteristics that support the validity of the classification system proposed by Belonozhenko et al. [4]. The structured grading scheme effectively predicted complication risks, including vitreous prolapse, IOP elevation, and cystoid macular edema [24], [31]. Previous studies have emphasized that such stratification is necessary for planning surgical management and preventing sight-threatening complications [10], [28]. The observed association between displacement depth and the likelihood of requiring complex surgery matches trends documented in studies of posterior chamber IOL instability [18], [29]. Moreover, the usefulness of multimodal imaging—UBM, B-scan, and OCT—is consistent with international recommendations for evaluating posterior segment involvement [19], [32]. These results reinforce the importance of standardized diagnostic tools in guiding appropriate clinical and surgical decision-making.

While Grade I cases generally require only observation, Grades II through IV necessitate increasingly complex interventions, a progression pattern described extensively in the surgical literature [17], [21]. In Grade II, capsular fibrosis and zonular rupture are early warning indicators of impending posterior dislocation, similar to findings reported by Shingleton et al. and Hayashi et al. [16], [18]. Grade III progression, marked by inferior migration of the ICBC, reflects significant zonular disruption documented in long-term PEX studies [25], [27]. Elevated intraocular pressure in Grade III patients aligns with known mechanisms of trabecular obstruction or secondary angle complications resulting from posterior dislocation [9], [24]. Grade IV cases requiring urgent vitreoretinal intervention mirror reports of severe posterior IOL dislocation associated with retinal traction and detachment [30], [33]. These patterns highlight the need for timely recognition of disease progression to prevent irreversible ocular damage.

The results of this study highlight important areas for potential improvement in postoperative care, especially for patients predisposed to zonular instability [11], [14]. Early detection strategies, such as scheduled long-term surveillance for PEX patients, may reduce the risk of late high-grade dislocation requiring extensive vitreoretinal surgery [15], [22]. This aligns with current recommendations encouraging risk-based follow-up intervals rather than uniform postoperative timelines [23], [28]. Enhanced patient education on symptoms such as glare, halos, or sudden vision changes could promote earlier clinical presentation and intervention [24], [29]. Furthermore, improved monitoring of capsular contraction using slit-lamp imaging and UBM may provide early indicators of structural instability [26], [31]. Together, these strategies could improve long-term outcomes and decrease the incidence of severe complications.

Comparative analysis indicates that ICBC dislocation remains a clinically relevant postoperative concern, despite advancements in cataract surgery and IOL technology [5], [7]. The variability in onset—often occurring years after an initially successful procedure—underscores the chronic biomechanical nature of the condition [12], [25]. Current research suggests that further understanding of capsular biomechanics and zonular aging is needed to refine preventive strategies [33], [34]. The present findings contribute important clinical evidence supporting severity-based classification and individualized surgical planning. These results strengthen existing knowledge on managing late IOL dislocation and provide a basis for future improvements in patient-centered postoperative care [20], [37]. Thus, the study supports both theoretical understanding and practical applications in ophthalmic clinical practice.

Conclusion

This study concludes that spontaneous dislocation of the intraocular lens–capsular bag complex can occur several years after cataract surgery, particularly in patients with pseudoexfoliation syndrome . Each severity grade identified in this study corresponds to distinct clinical manifestations, ranging from subclinical glare symptoms to severe posterior segment complications. These differences determine the urgency and complexity of required surgical intervention. The study reinforces the importance of long-term monitoring for high-risk patients, as late complications often arise after years of progressive zonular deterioration. The findings align with prior literature but also provide additional

clinical insights specific to ICBC progression patterns. Therefore, the study contributes meaningfully to ongoing ophthalmic research.

The severity grading system proved effective in stratifying patients according to clinical risk and surgical need. Its structured approach improved diagnostic accuracy and enabled more precise selection of appropriate interventions. The findings also highlight the essential role of multimodal imaging in assessing dislocation severity and identifying associated complications. The study emphasizes the importance of individualized patient assessment because progression varies significantly depending on zonular stability and capsular health. These considerations help optimize surgical outcomes and reduce postoperative complications. Thus, the grading framework demonstrates substantial practical value for clinicians.

Patients with pseudoexfoliation syndrome require special attention due to their high susceptibility to late ICBC dislocation. Regular long-term follow-up may significantly reduce the incidence of severe complications requiring vitreoretinal surgery. Early detection of capsular contraction, zonular weakness, or early optic decentration may prevent progression into Grades III or IV. The study highlights the need for improved postoperative education to empower patients in recognizing early warning signs. Increased awareness may lead to earlier clinical visits and prompt intervention. This aligns with global guidelines emphasizing preventive strategies for PEX-associated ocular diseases.

The study also underscores the need for further research regarding long-term biomechanical stability of the capsular bag. Such investigations may support innovations in IOL design, zonular support devices, or capsular tension rings that could reduce the risk of late dislocation. Biotechnology-driven approaches may eventually provide new materials capable of enhancing capsular stability over time. Exploring predictive markers of zonular degeneration could also improve individualized patient monitoring. These directions offer promising avenues for enhancing ophthalmic surgical outcomes. Continued research is therefore essential to improving long-term postoperative care.

In conclusion, the study successfully achieves its objective of evaluating the frequency, causes, and timing of late postoperative ICBC dislocation. The structured analysis improves understanding of the disease spectrum and supports clinical decision-making based on severity patterns. Recognition of grade-specific progression aids in planning the most effective surgical interventions. The findings highlight ongoing challenges in preventing long-term complications following cataract surgery. Overall, the study provides meaningful contributions to clinical ophthalmology and offers direction for future improvements in postoperative management. Its insights are expected to guide enhanced patient care and future research in the field.

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