Outcomes of Posterior Segment Intraocular Foreign Body Removal in Cataractous Eyes: Comparing Surgical Approaches

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ABSTRACT

Background: Penetrating ocular injuries complicated by retained intraocular foreign bodies (IOFBs) in the posterior segment are vision-threatening emergencies. These injuries are frequently associated with traumatic cataracts, further complicating surgical intervention. The optimal surgical route for IOFB removal—either via the limbus (anterior approach) or the pars plana (posterior approach) remains a matter of clinical debate. Each method has its own anatomical advantages, surgical risks, and implications for visual recovery. This review aims to evaluate the outcomes of posterior segment IOFB removal in eyes with coexisting cataract, comparing the limbal and pars plana surgical routes. The article outlines diagnostic imaging techniques, surgical decision-making based on IOFB characteristics, instrumentation, timing of intervention, intraoperative challenges, and long-term outcomes. Special emphasis is placed on postoperative complications such as retinal detachment, proliferative vitreoretinopathy (PVR), and sympathetic ophthalmia (SO).

Conclusion: Both limbal and pars plana approaches have demonstrated clinical efficacy in removing posterior segment IOFBs in the presence of cataract, with outcomes dependent on injury type, IOFB features, timing of intervention, and surgical expertise. The limbal approach is often utilized when cataract extraction is performed simultaneously, while the pars plana route offers better access to the posterior segment and may reduce traction-related retinal injury. Advancements in vitrectomy technology and microsurgical tools have enhanced the safety of both techniques. Nevertheless, careful preoperative planning, individualized surgical strategy, and vigilant postoperative monitoring remain critical to optimizing visual outcomes and minimizing complications

Keywords: *Posterior Segment, Intraocular Foreign Body Removal, Cataract*

Introduction

Ocular trauma is a significant cause of monocular visual impairment worldwide, with intraocular foreign bodies (IOFBs) accounting for a substantial proportion of penetrating eye injuries, particularly in young male populations involved in industrial or agricultural work [1]. When IOFBs lodge within the posterior segment, the risk of visual deterioration increases due to associated complications such as endophthalmitis, retinal detachment, and vitreous hemorrhage [2]. These injuries are frequently accompanied by lens damage, leading to cataract formation, which necessitates simultaneous or staged cataract management during IOFB removal.

The surgical approach to managing posterior segment IOFBs in the presence of cataract has evolved considerably with the advent of advanced microsurgical techniques. Traditionally, IOFBs were removed through the anterior segment following lensectomy, especially in cases of large corneal or scleral wounds. However, the introduction of modern vitrectomy systems has shifted the trend toward pars plana vitrectomy (PPV), which offers better visualization and access to posterior segment structures [3].

The choice of approach—via the limbus or pars plana—is guided by multiple factors, including the location and size of the IOFB, associated ocular injuries, status of the lens, and surgeon preference. Each technique has unique implications for intraoperative maneuverability, risk of iatrogenic retinal trauma, and long-term visual prognosis. Therefore, a comprehensive evaluation of outcomes and complications associated with these surgical strategies is essential to inform clinical decision-making and improve patient care.

This review synthesizes current evidence and clinical experiences on the outcomes of posterior segment IOFB removal in cataractous eyes, comparing the limbal and pars plana routes, while highlighting key aspects of diagnosis, surgical management, and postoperative complications.

Imaging Modalities in Penetrating Ocular Injuries with IOFBs

Accurate localization and characterization of intraocular foreign bodies (IOFBs) are critical steps in the diagnostic evaluation of penetrating ocular injuries. Early and precise imaging not only guides surgical planning but also aids in predicting potential complications. The choice of imaging modality depends on the clinical presentation, clarity of the ocular media, and suspected material of the IOFB.

Plain X-ray is often the initial modality used due to its wide availability and utility in detecting radiopaque foreign bodies. However, it lacks the spatial resolution necessary for precise localization and cannot identify radiolucent materials such as organic wood or plastic [4].

Computed Tomography (CT) scanning remains the gold standard for IOFB detection, offering high sensitivity and specificity for both metallic and non-metallic objects. Thin-slice, non-contrast axial CT scans can localize IOFBs in three dimensions and assess associated injuries such as orbital fractures or intraorbital hemorrhage [5]. However, motion artifacts and beam hardening can interfere with image interpretation in some cases.

Ultrasound B-scan is particularly useful in detecting IOFBs in settings of media opacity, such as dense cataracts or vitreous hemorrhage. It can also provide real-time information on IOFB mobility, vitreoretinal traction, and the presence of retinal detachment. Care must be taken, however, as excessive pressure on a traumatized globe may worsen the injury [6].

Magnetic Resonance Imaging (MRI) is contraindicated if a metallic IOFB is suspected due to the risk of migration and tissue damage from magnetic field interactions. It may be selectively used when non-metallic materials like wood are suspected and CT is inconclusive.

In practice, CT and B-scan ultrasonography are complementary tools, offering a detailed understanding of IOFB characteristics and guiding the optimal surgical approach

Surgical Management of Penetrating Ocular Injuries with Retained Posterior Segment IOFBs

Early vs. Delayed Removal of Posterior Segment IOFBs

Timing of IOFB removal is a crucial determinant of visual prognosis and complication rates. **Early removal**, typically within 24–72 hours post-injury, is advocated to minimize the risk of endophthalmitis, toxic reactions from metallic IOFBs (e.g., siderosis or chalcosis), and mechanical damage to intraocular structures [7]. Prompt intervention also allows for better visualization before the onset of inflammation or proliferative vitreoretinopathy (PVR).

Conversely, **delayed removal** may be considered in cases where the eye is inflamed, the patient is systemically unstable, or advanced vitrectomy equipment is unavailable. In some scenarios, initial primary repair is performed with IOFB extraction deferred until intraocular conditions are optimized [8]. However, delayed removal carries a higher risk of retinal detachment, infection, and PVR, especially if the IOFB is metallic or contaminated.

The consensus among vitreoretinal surgeons leans toward early intervention when feasible, particularly in eyes with retained metallic IOFBs or those at risk of infectious complications.

Methods of Retained Posterior Segment IOFB Extraction

The surgical approach to posterior segment intraocular foreign body (IOFB) extraction is largely determined by the location, size, shape, composition of the foreign body, and associated ocular injuries. The two primary approaches for posterior IOFB removal in the presence of coexisting cataract are through the **limbus (anterior route)** and the **pars plana (posterior route)**.

The **limbal route** is typically selected when a cataract is present or requires extraction concurrently. After phacoemulsification or extracapsular cataract extraction, access to the posterior segment is gained via the anterior segment, and the IOFB is removed through the enlarged limbal wound using intraocular forceps or magnets [9]. This approach, however, offers limited posterior visualization and carries a higher risk of zonular damage, vitreous prolapse, and retinal traction.

The **pars plana approach** is now preferred by many surgeons, especially when posterior segment pathology (e.g., vitreous hemorrhage, retinal tear) coexists. A standard 23-, 25-, or 27-gauge pars plana vitrectomy (PPV) is performed to clear the vitreous and visualize the IOFB. The foreign body is then removed either through an enlarged sclerotomy or, in some cases, via an auxiliary limbal incision if the IOFB is large or sharp-edged [10]. This method allows better control of vitreoretinal structures, minimizes anterior segment disturbance, and facilitates management of coexisting retinal injuries.

In some cases, hybrid techniques combining both routes are utilized, particularly in eyes with large, anteriorly dislocated IOFBs or when cataract surgery is planned simultaneously. The choice of route should be individualized based on preoperative imaging, surgical expertise, and the patient's visual potential.

Instruments for IOFB Removal & Methods of IOFB Handling

Successful extraction of posterior segment intraocular foreign bodies (IOFBs) relies on appropriate instrumentation and careful intraoperative handling to prevent iatrogenic trauma, especially to the retina and optic nerve. The choice of instruments depends on the IOFB's material, shape, size, and mobility.

Intraocular forceps are the most commonly used tools for IOFB retrieval. Micro-forceps with fine serrated tips allow firm grasping of small or irregularly shaped objects. End-grasping and diamond-dusted forceps provide enhanced grip, particularly for slippery metallic bodies [11].

Magnets are used when the IOFB is ferromagnetic. Rare-earth magnets can be applied externally or intraocularly via the pars plana. However, this method carries a higher risk of abrupt IOFB movement, which may cause retinal damage if not precisely controlled. Magnets are thus best reserved for non-embedded, freely mobile metallic IOFBs [12].

IOFB baskets and snares are employed for larger or irregular objects that are difficult to grasp directly. These retrieval devices can encapsulate the foreign body, enabling safe removal through an enlarged sclerotomy or corneal incision. Flexible nitinol loops are particularly useful for gently enclosing the IOFB without causing additional damage [13].

For **sharply edged or irregular IOFBs**, a protective sheath, such as a soft-tipped cannula or a custom-made silicone sleeve, may be used to avoid injury to intraocular structures during extraction. In such cases, pre-planned wound enlargement is crucial to allow smooth delivery of the foreign body.

Intraoperative **perfluorocarbon liquids (PFCLs)** may be applied to stabilize the retina and float the IOFB anteriorly for safer manipulation. Additionally, **intraocular illumination and wide-angle visualization systems** facilitate precise maneuvering within the vitreous cavity and posterior pole.

Mastery of a range of IOFB-specific tools and techniques enhances surgical control and minimizes complications associated with foreign body retrieval.

Intraoperative Complications

Intraoperative complications during posterior segment intraocular foreign body (IOFB) removal can significantly influence visual prognosis and structural outcomes. These complications are often related to limited visualization, retinal adhesion to the IOFB, or inadequate wound construction. Their incidence can vary based on the surgical approach, IOFB characteristics, and surgeon experience.

One of the most concerning risks is **iatrogenic retinal breaks or tears**, which may occur when the IOFB is inadvertently dropped or dragged across the retinal surface during manipulation. These breaks can lead to retinal detachment if not promptly addressed. Using perfluorocarbon liquids (PFCLs) to float and stabilize the IOFB during removal can help reduce traction on the retina [14].

Hemorrhage is another intraoperative risk, especially in cases where the IOFB has penetrated vascular structures or lies adjacent to the optic nerve or macula. Choroidal or vitreous hemorrhages may impair visualization and complicate surgical dissection. Gentle handling, appropriate use of cautery, and avoiding sudden movements are key preventive strategies [15].

Lens injury or zonular dialysis may occur during anterior approaches or in cases requiring combined cataract surgery. This can result in lens instability or residual lens fragments, necessitating conversion to intraocular lens (IOL) implantation or secondary intervention.

Other complications include **sclerotomy site extension**, especially when removing large or rigid IOFBs, and **expulsive choroidal hemorrhage** in cases of uncontrolled intraocular pressure fluctuations. These events can be mitigated with controlled infusion, gradual wound enlargement, and adequate preoperative ocular hypotensive management.

The surgeon's familiarity with diverse IOFB instruments, visualization tools, and intraoperative decision-making algorithms is essential for minimizing these complications and achieving favorable outcomes.

Post-operative Care and Complications

Post-operative management following intraocular foreign body (IOFB) removal is essential to optimize anatomical outcomes, preserve visual function, and prevent long-term complications. The care protocol typically includes the use of topical and systemic antibiotics, corticosteroids, cycloplegics, and close monitoring for signs of infection or retinal complications.

Topical antibiotics and steroids are routinely prescribed to reduce the risk of post-surgical inflammation and endophthalmitis. In cases where there is high suspicion of microbial contamination—particularly with organic IOFBs or delayed presentation—**intravitreal antibiotics** are administered prophylactically or therapeutically [16].

Systemic antibiotics, often a combination of broad-spectrum agents such as ceftazidime and vancomycin, are continued for 5–7 days. Oral corticosteroids may be added to control intraocular inflammation, but only after excluding active infection.

Cycloplegics like atropine or cyclopentolate are used to relieve ciliary spasm and prevent posterior synechiae formation. **Intraocular pressure (IOP)** should be monitored regularly, as inflammation or steroid response may lead to secondary ocular hypertension or hypotony.[16].

Postoperative visits are scheduled frequently in the early phase (daily to every few days), gradually tapering off over several weeks. **Serial fundus examinations and optical coherence tomography (OCT)** are used to monitor for macular edema, epiretinal membrane formation, or early signs of proliferative vitreoretinopathy (PVR).[16].

Common postoperative complications include **cystoid macular edema, retinal detachment, vitreous hemorrhage, and posterior capsular opacification**, especially when cataract extraction is performed. Secondary intraocular lens (IOL) implantation may be required in aphakic eyes or where primary IOL implantation was deferred due to trauma.[16].

The success of IOFB removal extends beyond surgery; diligent postoperative care and early detection of complications are vital to achieving optimal visual rehabilitation and structural stability.[16].

Post-Operative Retinal Detachment

Retinal detachment (RD) is one of the most serious and sight-threatening complications following intraocular foreign body (IOFB) removal. It can occur intraoperatively or in the postoperative period due to tractional forces, retinal breaks, or proliferative vitreoretinopathy (PVR). The reported incidence of RD after posterior segment IOFB injuries ranges from 10% to 40%, depending on the location and size of the IOFB, time to removal, and presence of associated injuries [17,18].

Mechanisms of RD include direct trauma from the IOFB, iatrogenic injury during removal, and secondary changes like PVR. Retinal impact sites may initially appear stable but may later develop tractional or rhegmatogenous detachment due to cellular proliferation and vitreoretinal traction [19]. The risk is especially high when the IOFB is large, has a sharp contour, or is embedded in the retina.

Preventive measures include careful preoperative assessment of retinal integrity using indirect ophthalmoscopy or intraoperative wide-angle viewing systems. The use of **perfluorocarbon liquids (PFCLs)** during surgery can help stabilize the posterior pole and minimize retinal movement during IOFB manipulation [20].

When RD is detected, **prompt vitrectomy with retinal reattachment** using tamponade agents (silicone oil or gas) is indicated. The choice of tamponade depends on the extent of detachment and whether a simultaneous cataract surgery has been performed. Retinal laser photocoagulation is applied to seal peripheral tears and reinforce impacted areas [21].

Prognosis following RD repair in these cases depends on the macular status at the time of detachment and presence of PVR. Close postoperative surveillance is essential, especially in high-risk eyes, to detect early signs of retinal traction or detachment.

Proliferative Vitreoretinopathy (PVR)

Proliferative vitreoretinopathy (PVR) is a major cause of surgical failure and poor visual prognosis following posterior segment intraocular foreign body (IOFB) injuries. It is characterized by the proliferation and contraction of fibrous cellular membranes on both surfaces of the retina and within the vitreous cavity, leading to recurrent or persistent retinal detachment [22].

PVR typically develops in response to retinal trauma, inflammation, hemorrhage, or the presence of retinal breaks. In the setting of IOFB injuries, the risk is significantly increased due to the severity of tissue damage, delayed surgical intervention, and associated hemorrhage or inflammation [23]. The release of retinal pigment epithelial (RPE) cells, macrophages, fibroblasts, and glial cells into the vitreous cavity contributes to membrane formation and tractional forces.

Clinically, PVR may present weeks after initial surgery with recurrent retinal detachment, retinal stiffness, or fixed folds. It is more commonly seen in cases where the IOFB impacted the retina, especially in the posterior pole or near the vascular arcades [24].

Prevention of PVR involves minimizing intraoperative trauma, ensuring complete vitrectomy, meticulous removal of blood and inflammatory debris, and sealing of all retinal breaks. Adjunctive use of pharmacologic agents such as corticosteroids or antimetabolites has been explored, but no consensus exists regarding their routine use in trauma-related PVR prevention [25].

Management of established PVR requires repeat pars plana vitrectomy with membrane peeling, relaxing retinotomies if needed, and the use of long-acting tamponade agents like silicone oil. Visual outcomes remain guarded, particularly when the macula is involved or multiple surgeries are required. Given the high morbidity associated with PVR, early identification of high-risk patients, close follow-up, and prompt intervention are essential for preserving vision[25].

Sympathetic Ophthalmia (SO)

Sympathetic ophthalmia (SO) is a rare, bilateral, granulomatous panuveitis that can occur after penetrating ocular trauma or intraocular surgery, including procedures for intraocular foreign body (IOFB) removal. It results from an autoimmune response directed against previously sequestered ocular antigens released during injury or surgery [26].

Although SO is uncommon, with an estimated incidence of 0.2% to 0.5% following ocular trauma, it remains a feared complication due to its potential to cause bilateral visual impairment. The inciting (injured) eye is referred to as the "exciting eye," while the contralateral eye, which becomes inflamed, is the "sympathizing eye" [27].

Clinically, SO typically presents weeks to months after the inciting event with bilateral symptoms such as blurred vision, photophobia, redness, and ocular pain. Examination may reveal anterior chamber and vitreous inflammation, Dalen-Fuchs nodules, serous retinal detachment, and papillitis. The condition is often diagnosed clinically, supported by a suggestive history of penetrating injury or intraocular surgery [28].

The risk of SO may be increased by delayed or complicated IOFB surgery, particularly in eyes with retained uveal tissue, poor wound closure, or multiple interventions. Prompt removal of severely traumatized, blind eyes within 10–14 days of injury has traditionally been recommended to reduce this risk, although modern management now emphasizes ocular preservation whenever feasible [29].

Treatment involves systemic immunosuppression, starting with high-dose corticosteroids followed by steroid-sparing agents such as azathioprine, cyclosporine, or mycophenolate mofetil. Early and aggressive therapy is crucial to control inflammation and prevent irreversible damage to the sympathizing eye [29].

Given the rarity but seriousness of SO, clinicians must maintain a high index of suspicion in post-trauma or post-IOFB extraction cases with bilateral uveitis, and initiate treatment promptly to preserve vision. [29].

Conclusion:

The management of posterior segment intraocular foreign bodies (IOFBs) in cataractous eyes represents a complex surgical challenge that demands individualized planning, appropriate imaging, and precise execution. The decision between **limbal** and **pars plana** routes for IOFB removal should be guided by IOFB location, size, material, coexisting ocular injuries, and surgeon expertise. The **limbal approach** may be suitable in cases where cataract extraction is concurrently required, while the **pars plana route** offers superior visualization and access to the posterior segment, particularly in complex or posteriorly embedded IOFBs.

Both techniques carry risks of intraoperative and postoperative complications, such as retinal detachment, proliferative vitreoretinopathy (PVR), and rare but vision-threatening conditions like sympathetic ophthalmia (SO). Advances in **vitrectomy instrumentation, imaging modalities, and adjunctive surgical techniques** have significantly improved the safety and efficacy of IOFB extraction procedures. However, **timely intervention**, proper postoperative care, and **vigilant follow-up** remain critical to ensuring optimal anatomical and visual outcomes.

Ongoing clinical studies and innovations in imaging and surgical technologies are likely to refine existing approaches and improve prognoses for patients with complex penetrating ocular injuries complicated by IOFBs and cataract.

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