

Clinical Characteristics, Outcomes, and Complications Associated With Delayed Diagnosis of Intraocular Foreign Body

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Abstract

Purpose: To describe the clinical characteristics, outcomes, and complications in cases of intraocular foreign bodies (IOFBs) when the diagnosis is missed or delayed. **Methods:** This nonconsecutive case series was a retrospective multicenter study of adult patients with a delayed diagnosis of IOFB, defined as initially presenting elsewhere with a missed diagnosis or a delay of more than 24 hours to seek care. **Results:** Eighteen eyes were included. The mean (\pm SD) presenting logMAR visual acuity (VA) was 0.45 ± 0.70 (Snellen equivalent, 20/56). The most common presenting symptom was decreased vision (11 patients [61%]). The general emergency department setting accounted for most initial evaluations (11 patients [61%]); however, 6 patients (33%) were seen in an outpatient setting by an optometrist, ophthalmologist, or both. The most common anatomic locations of the IOFBs were in the iris/anterior chamber (4 [22%]) or lens (4 [22%]) followed by the pars plana/ciliary body (3 [17%]), vitreous (3 [17%]), or retina (3 [17%]). Complications at presentation included endophthalmitis (1 [6%]), retinal detachment (1 [6%]), and retinal tears (4 [22%]). Five patients (28%) had siderosis at presentation. The mean final logMAR VA was 0.13 ± 0.32 (Snellen equivalent, 20/26). At the last follow-up, 15 eyes (83%) had a VA of 20/30 or better. The median follow-up was 139 days (IQR, 86–557). **Conclusions:** Eyes with a delayed diagnosis of IOFBs often present with good vision and self-sealing wounds. Missed IOFBs can be associated with siderosis, RD, and endophthalmitis. Visual outcomes may be salvaged with prompt treatment.

Keywords

delayed IOFB, open-globe injury, intraocular foreign body

Introduction

Intraocular foreign bodies (IOFBs) are present in 14% to 42% of open-globe injuries in adults in the United States.^{1–4} In the majority of cases, by a combination of examination and imaging, IOFBs are diagnosed promptly in the initial trauma evaluation. However, rarely, the diagnosis of IOFB can be missed or delayed.

Complications of a missed IOFB are varied and depend on the size and location of the IOFB as well as the composition of its material. Although some studies of IOFBs describe a relatively equal distribution between the anterior and posterior segment, the majority of studies report that IOFBs are more commonly found in the posterior chamber.^{2,5–7} Superficial foreign bodies in the conjunctiva or sclera are relatively rare and can present as foreign-body granulomas.^{8–10} Foreign bodies in the anterior chamber, such

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as in the iris or iridocorneal angle, may cause few or no symptoms initially and thus might be more likely to be missed, especially in cases with ambiguous histories.¹¹ Over time, anterior chamber IOFBs can cause low-grade recurrent uveitis, corneal edema as a sequela of corneal endothelial damage, increased intraocular pressure, and lens opacities.¹²⁻¹⁴

Patients with IOFBs in the posterior segment that cause immediate vision changes as a result of complications, such as a vitreous hemorrhage or retinal detachment (RD), may be more likely to present for acute evaluation. Eyes with a delayed IOFB diagnosis may have a predilection for secondary endophthalmitis, orbital cellulitis, RDs, and proliferative vitreoretinopathy (PVR).¹⁵⁻¹⁸

Even in cases of ocular trauma in which an IOFB has been identified, suspicion must remain high given that multiple IOFBs are found in as many as 22.6% of eyes with open-globe injuries.⁴ Computed tomography (CT) scans are more reliable than a clinical examination or B-scan echography for the identification of IOFBs and can detect a variety of materials.² The majority of IOFBs are metallic.^{5,6} Metallic IOFBs can cause siderosis or chalcosis, depending on the composition of the metal.^{19,20} Siderosis can develop from days to years after the initial injury.²¹

We aimed to characterize patients presenting with a delayed diagnosis of IOFB, with a focus on causative factors, complications, and visual outcomes.

Methods

This was a retrospective review of patients with a delayed diagnosis of IOFBs who presented to Massachusetts Eye and Ear (MEE), the University of Iowa, Maine Medical Center, Retina-Vitreous Surgeons of Central New York, SUNY Upstate Medical University, or Bascom Palmer Eye Institute from 2010 to 2023. The study conformed to the tenets of the Declaration of Helsinki and was prospectively approved by the Institutional Review Board, Massachusetts General Brigham (protocol ID #2023P002796). The requirement for informed consent was waived given the retrospective nature of the study.

Clinical data were retrieved from the electronic medical record (EMR). Patients were included if there was an initial misdiagnosis of the IOFB (eg, misdiagnosis as a corneal abrasion or corneal foreign body) or if the patient had not initially sought care but presented after a delay to care of 24 hours or more. Cases at MEE were found through an EMR search, and other cases were sought via consultation with colleagues.

On presentation (regardless of a delayed or previously missed IOFB diagnosis), all patients received a full ophthalmologic evaluation, including best-corrected Snellen visual acuity (VA) measurement, a slit lamp examination, and a dilated fundus examination. Counting fingers, hand motions, and light perception (LP) were assigned Snellen values of 20/1500, 20/4000, and 0.04/200, respectively.^{22,23}

All patients had thin-slice CT imaging through the orbits/face. IOFBs were thus found at the initial examination, on the CT scan, or during surgical repair of RDs not initially known to be associated with an IOFB. The location of each IOFB was described in the

examination report or in the operative report. The open-globe injuries were classified by zones of injury as described by Pieramici et al,²⁴ and the anatomic location of the IOFB in the eye was documented.

One patient was not included in analyses, given a presenting VA of no LP (NLP) and a severe open-globe injury that precluded adequate evaluation for an IOFB at the initial presentation.

A standardized table was used to collect data, including the patients' demographics, presentation, diagnostic testing, management, and outcomes. Outcomes of interest included the length of delay in diagnosis; possible contributors to a delay in diagnosis (symptoms or examination findings); complications, including infection, retinal tear, RD, or siderosis; the number of surgeries; and the VA at follow-up. For continuous variables (eg, VA), summary statistics, including the mean \pm SD, median, and IQR, were calculated. For categorical variables, a descriptive analysis of the outcomes was performed and presented as percentages. Analysis and descriptive statistics were performed using SPSS software (version 28, SPSS Inc). Statistical significance was set at $P < .05$.

Results

The EMR search and multi-institution consultation outreach found 19 patients, 1 of whom is reported but was excluded from the statistical analysis. The remaining 18 eyes of 18 patients (94% men) had a median age at presentation of 35.5 years (IQR, 27-45). Table 1 shows the presenting characteristics of the patients.

The median length of follow-up was 139 days (IQR, 86-557). The median delay from injury to diagnosis was 14 days (IQR, 5-92) and ranged from 2 days to 3669 days (IQR, 10 years). The median delay between the injury and the first subsequent surgery (IOFB removal) was 16 days (IQR, 5-118).

Presentation

The mean presenting logMAR VA was 0.45 ± 0.70 (Snellen equivalent, 20/56). Twelve eyes (67%) had a VA of 20/30 or better at presentation, and 3 (17%) had poorer VA of between 20/300 and LP (Table 2). The most common presenting symptom was subjectively decreased vision followed by conjunctival injection (Table 1). Other common complaints were photophobia, abnormal anatomic findings (eg, heterochromia) (Figure 1A), anisocoria, irritation/foreign-body sensation, pain, and flashes/floaters. Only 1 patient (6%) was entirely asymptomatic and diagnosed by an outside provider on routine examination (Table 1).

Table 1 shows the mechanisms of injury. The majority of patients were working with metal without power tools, for example removing screws or hammering metal. The next most common mechanism was grinding metal with power tools followed by blunt trauma and then nail gun use.

Table 1 also shows the setting of the initial evaluation during which the diagnosis of IOFB was missed. This occurred most often in the general emergency department setting (11 patients [61%]). In the outpatient setting, the most common practitioner

Table 1. Presenting Characteristics (18 Patients).

| Characteristic | Value |
|---|---------|
| Age (y) | |
| Median | 35.5 |
| IQR | 27-45 |
| Sex, n (%) | |
| Male | 17 (94) |
| Female | 1 (6) |
| Delay in diagnosis (d) | |
| Median | 14 |
| IQR | 5-92 |
| Delay between injury and surgery (d) | |
| Median | 16 |
| IQR | 5-118 |
| Mechanism of injury, n (%) | |
| Working with metal, no power tools ^a | 10 (56) |
| Grinding metal with power tools | 5 (28) |
| Nail gun | 1 (6) |
| Blunt trauma | 2 (11) |
| Presenting symptoms, n (%) | |
| Decreased vision | 11 (61) |
| Conjunctival injection | 6 (33) |
| Irritation/foreign body sensation | 4 (22) |
| Pain | 4 (22) |
| Photophobia | 5 (28) |
| Abnormal anatomic finding ^b | 5 (28) |
| Flashes/floaters | 3 (17) |
| Asymptomatic | 1 (6) |
| Initial evaluation ^c , n (%) | |
| By general emergency department | 11 (61) |
| By optometrist | 2 (11) |
| By ophthalmologist | 5 (28) |
| By primary care physician | 1 (6) |
| None | 1 (6) |
| Imaging studies obtained at initial evaluation, n (%) | |
| None | 16 (89) |
| X-ray | 1 (6) |
| Computed tomography | 1 (6) |
| Anatomic location of IOFB, n (%) | |
| Cornea | 1 (6) |
| Iris/anterior chamber | 4 (22) |
| Lens | 4 (22) |
| Pars plana/ciliary body | 3 (17) |
| Vitreous | 3 (17) |
| Retina | 3 (17) |

Abbreviation: IOFB, intraocular foreign body.

^aFor example, hammering, removing screws.

^bFor example, heterochromia, iris lesion, anisocoria.

^cSome patients were seen in multiple settings before the correct diagnosis of IOFB was made. One patient was seen by an emergency department and an ophthalmologist, and 1 was seen initially by an optometrist and an ophthalmologist, with all missing the correct diagnosis. Thus, the numbers add up to more than 18 patients or 100%.

was an ophthalmologist followed by an optometrist and then the primary care physician. One patient (6%) did not initially

Table 2. Ocular Characteristics and Surgical Interventions (N = 18).

| Characteristic | Value |
|--------------------------------------|---------|
| Visual acuity in affected eye, n (%) | |
| At presentation | |
| $\geq 20/30$ | 12 (67) |
| $< 20/30$ and $\geq 20/50$ | 1 (6) |
| $< 20/50$ and $\geq 20/80$ | 0 |
| $< 20/80$ and $\geq 20/150$ | 1 (6) |
| $< 20/150$ and $\geq 20/300$ | 1 (6) |
| 20/300 to LP | 3 (17) |
| NLP | 0 |
| At last follow-up | |
| $\geq 20/30$ | 15 (83) |
| $< 20/30$ and $\geq 20/50$ | 2 (11) |
| $< 20/50$ and $\geq 20/80$ | 0 |
| $< 20/80$ and $\geq 20/150$ | 0 |
| $< 20/150$ and $\geq 20/300$ | 0 |
| 20/300 to LP | 1 (6) |
| NLP | 0 |
| Surgical interventions (n) | |
| Median | 1 |
| Range | 0, 2 |
| Type of surgery, n (%) | |
| Anterior removal of IOFB | 7 (39) |
| Pars plana vitrectomy | 10 (56) |
| Endolaser | 8 (44) |
| Gas | 4 (22) |
| Lensectomy/cataract surgery | 8 (44) |
| Closing of entry wound | 5 (28) |
| Intraoperative antibiotics, n (%) | |
| Intravitreal | 4 (22) |
| Subconjunctival | 5 (28) |
| IOFB material, n (%) | |
| Glass | 1 (6) |
| Organic material | 1 (6) |
| Metallic | 14 (78) |
| Unknown | 2 (11) |

Abbreviations: IOFB, intraocular foreign body; LP, light perception; NLP, no light perception.

seek care but presented 3 weeks later with an IOFB; the other 17 patients (94%) initially sought care within 48 hours.

Intraocular Foreign-Body Characteristics

The 2 most common anatomic locations of the IOFB were the iris/anterior chamber and the phakic lens followed by the pars plana/ciliary body, vitreous, and retina (Table 1). Notably, the entry wounds in all eyes were anterior; 16 (89%) were zone I injuries, and 2 (11%) were zone II injuries.

The majority of IOFBs (78%) were metal. One was glass (6%); 1 (6%) was organic material, likely wood; and 2 (11%) were of unknown material (Table 2).

All but 2 patients had no imaging at initial presentation, contributing to the missed initial diagnosis. One patient had an

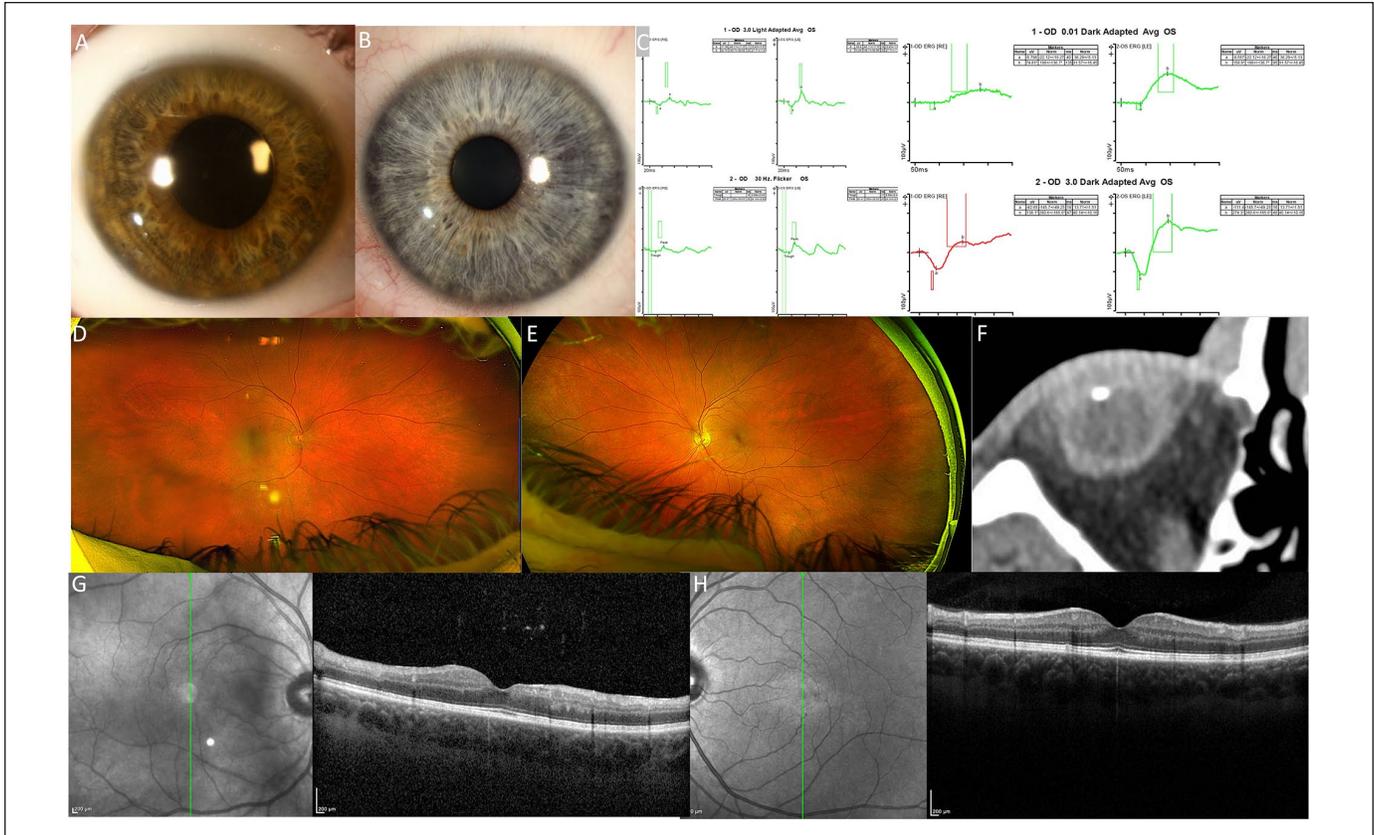


Figure 1. An illustrative case. A 47-year-old man presented 10 years after his last time grinding metal, during which he sustained a piece of metal to the eye and was diagnosed with a corneal foreign body. He then developed a unilateral cataract and had cataract surgery by an outside ophthalmologist, who also did not diagnose the intraocular foreign body (IOFB) but subsequently referred the patient to the retina clinic given the visual field constriction and heterochromia [(A) affected eye with iris heterochromia; (B) unaffected eye]. The presenting symptoms included heterochromia and the unilateral cataract status after removal, with subnormal responses on the electroretinogram (ERG) (C), and retinal thinning on optical coherence tomography (OCT) [(G) affected right eye; (H) unaffected eye], although with 20/20 visual acuity (VA). A dilated fundus examination showed speckled pigmented changes in the affected eye (D), and computed tomography confirmed the presence of an IOFB in the posterior segment (F). The patient retained good central VA after pars plana vitrectomy with IOFB removal. At postoperative year 1.5, the visual fields, ERG, and OCT remained stable.

X-ray of the face as the initial imaging study, which missed the IOFB. One patient's glass IOFB was missed on CT, which was performed promptly, and was only seen on open-globe repair. Sixteen patients' IOFBs (89%) were confirmed on a CT scan; 1 (5.6%) was confirmed on X-ray, and 1 (5.6%) was not seen on imaging before the open-globe repair. B-scan ultrasound contributed to the diagnosis in 2 cases (11%), and ultrasound biomicroscopy (UBM) contributed to the diagnosis in 3 cases (17%); both imaging modalities were accompanied by a CT scan, in which the IOFB was more obvious.

Management

The majority of patients (12 [67%]) had only 1 surgery, while 5 patients (28%) had 2 surgeries. One patient did not have surgery because he was still considering it at the time of this manuscript preparation (Table 2).

Table 2 shows the types of surgery. The most common was pars plana vitrectomy (PPV) followed by endolaser application, lensectomy/cataract surgery, anterior removal of the IOFB, closing of entry wound, and gas placement. Although all wounds had initially self-sealed (no Seidel-positive wounds on presentation), 5 surgeries (28%) did not include closing the entry wound.

Intraoperative antibiotics, most commonly vancomycin and ceftazidime, were used in 9 patients (50%). Subconjunctival antibiotics (cefazolin in all cases except vancomycin, ceftazidime, and fluconazole in 1 case of an organic matter IOFB) were used in 5 cases (28%), and intravitreal antibiotics (vancomycin and ceftazidime) were used in 4 cases (22%) (Table 2).

Specific Factors Contributing to Missed Diagnoses

All patients had Seidel-negative, self-sealed wounds. Cases missed by outside emergency departments were all initially misdiagnosed

as corneal abrasions or corneal foreign bodies. Only 1 patient received imaging, an X-ray that did not show an obvious foreign body. In 3 cases seen by ophthalmologists, the IOFB was in the angle or ciliary body and was causing intraocular inflammation that was mistaken for traumatic iritis or anterior uveitis.

One case presented to an outside ophthalmologist years after the initial injury and was found to have an iris lesion. Because the patient did not volunteer the history of trauma, the iris lesion was thought to be neoplastic instead.

Five eyes (18%) had no lens violation. Six eyes (33%) did have lens violation and presented later with traumatic cataract; however, given the small size of the foreign bodies, the eyes likely did not have a significant cataract immediately after the injury when they initially presented.

Complications/Outcomes

At presentation, 1 patient (6%) had endophthalmitis, 1 (6%) had an RD, and 4 (22%) had retinal tears. Five patients (28%) had siderosis at presentation, 4 with electroretinogram (ERG) evidence and 1 with evidence on examination (heterochromia, anisocoria) (Figure 1). The patients with siderosis presented with delays of 9 weeks, 20 weeks, 28 weeks, 8 years, and 10 years. These patients all had excellent vision (VA 20/20 or 20/25).

During the course of the follow-up, no patient developed endophthalmitis, PVR, or horseshoe retinal tears. One patient (6%) developed a giant retinal tear, and 1 patient (6%) developed an RD.

The mean final logMAR VA was 0.13 ± 0.32 (Snellen equivalent, 20/26) (Table 2). At the last follow-up, 15 eyes (83%) had a VA of 20/30 or better, 2 eyes (11%) had moderately decreased vision (between 20/30 and 20/50), and 1 eye (6%) had poor vision (20/400). No eye had a VA worse than 20/400.

The case not included in analysis was a 51-year-old patient who presented after a firework blast injury to the left eye. He presented with a VA of NLP, globe collapse, vitreous coating the lids, a stellate corneal laceration, a scleral laceration, uveal prolapse, and a dense hemorrhage in the anterior chamber. Informal B-scan echography performed at bedside was equivocal for an IOFB; however, a CT scan showed no radio-opaque foreign matter. After the primary repair, the patient subsequently had PPV with lensectomy, at which time fibrous IOFBs were identified. The VA remained NLP at postoperative year 3.

Conclusions

In this multicenter study of delayed or initially missed presentations of IOFBs, we found that complications can occur but with generally favorable outcomes.

The demographics of our cohort are consistent with those in other studies of eye trauma and open-globe injury/IOFB; that is, young (median age, 35 years) with the majority (94%) being men. These characteristics are similar to those in previous studies^{1,4,5,7} and likely reflect the occupational risks and recreational activities of this demographic group.

The most common presenting symptom was subjectively decreased VA (11 patients [61%]). Interestingly, many of these patients had an objectively favorable VA (20/25 or 20/30) but were still symptomatic from decreased or blurry vision. This finding may be explained by a generally young population with excellent baseline vision and preserved vision in the fellow eye, thus causing a noticeable difference even with 20/25 or 20/30 VA. This observation underscores the importance of thoroughly evaluating even a small decline in vision, especially in younger patients with a history suggestive of trauma. That the decrease in vision was only mild may have been an important contributor to the initial missed diagnosis because normal or only mildly subnormal vision would have been less likely to alert the initial provider to pursue further testing. In contrast to this study, patients with typical open-globe injuries with IOFBs have more severely decreased VA—worse than 20/80 in 50% of a cohort from a participating institution in this study, 91% with 20/50 or worse in a cohort from China, and a median of 20/200 in a German cohort.^{4,6,7}

In some cases, the decreased vision was caused by the development of a traumatic cataract, a finding that typically progresses over time and thus may not have been present on initial evaluation when the IOFB was missed. Aside from the subjectively decreased vision, other common symptoms included eye redness, irritation, photophobia, pain, or flashes/floaters. Several patients also noticed abnormal anatomic findings, such as anisocoria, heterochromia, or an iris lesion. Only 1 patient was entirely asymptomatic. Thus, overall, the symptoms in many cases were mild. In a notable example, given a lack of subjective symptoms, 1 patient with a metallic iris foreign body present for 8 years was hesitant to receive surgery, despite ERG evidence of retinal damage. He was still considering whether to have surgery at the time of this manuscript writing.

A constellation of factors contributed to the missed and delayed diagnoses, including a benign-appearing initial examination, minimal symptoms, and a misdiagnosis. For example, in general eyes with missed IOFBs had self-sealed entry wounds, a small entry wound, or both, as was the case in all patients in this cohort. In addition, the majority were zone I injuries; 2 were more-posterior zone II injuries. It is logical that these would be the most missed types of IOFBs and thought to be corneal abrasions or corneal foreign bodies, which in general are more frequent and less severe types of injury. It may be reasonable in the general emergency department setting to have a lower threshold to obtain appropriate imaging in cases with high-risk injury mechanisms. In addition, the overall good vision at presentation would likely have led to a lower suspicion for an IOFB, in particular in the general emergency department setting. Finally, relapsing low-grade anterior chamber inflammation with an unclear cause and a history of trauma should raise suspicion for a possible missed IOFB, and a CT scan of the orbits may be considered.

In this cohort, the anatomic locations of the IOFBs ranged throughout the eye. Of interest, 44% of delayed IOFBs in this cohort were in the iris, anterior chamber, or phakic lens, locations that can theoretically be seen on an anterior slit lamp examination, if available, by general emergency department practitioners.

Teaching the technique of retroillumination to check for iris transillumination defects may be particularly valuable for general emergency room practitioners, especially in locations without ophthalmology coverage.

Alternatively, given the ever-increasing volume and burden on general emergency departments, perhaps a lower threshold for transfer to a trauma center with ophthalmology coverage may be necessary, especially given that most IOFBs tend to be in the posterior segment.^{2,5-7} The missed diagnoses by optometrists and ophthalmologists tended to be atypical presentations of IOFBs; for example, having an angle or pars plana/ciliary body location with an anterior chamber reaction mimicking traumatic iritis or anterior uveitis. Gonioscopy or a 3-mirror evaluation of the ciliary sulcus should thus be considered if the suspicion for an IOFB is high.

Imaging studies play a large role in the diagnosis as well, with 16 of our 18 cases being missed, at least partially because of a lack of imaging at the initial evaluation. An IOFB in 1 case was missed because the ophthalmologist relied on a plain radiograph of the face obtained at an outside hospital that did not show an IOFB; an IOFB hidden in the ciliary body was seen later on UBM. This case highlights the need for the appropriate imaging modality. Although in this case the IOFB was identified on ultrasound, CT imaging has the highest sensitivity for detection of IOFBs and should be performed in all cases of open-globe injuries or if there is a suspicion for an IOFB, as was done in the majority of cases in this series.

Previous reports have shown similar sensitivity for 1.0 mm and 3.0 mm slices in CT imaging for detection of IOFBs,^{25,26} although there may be a trend toward 1.0 mm slices being more sensitive for very small IOFBs.²⁵ In a series of open-globe injuries with IOFBs, Patel et al² found that a CT scan of the orbits identified IOFBs in 94.9% (56/59) of cases, whereas IOFBs were missed in 40 of 74 cases during the initial eye examination and in 13 of 27 cases by B-scan. Thus, careful history taking with a focus on eliciting possible trauma as well as obtaining appropriate imaging with CT might help prevent emergency room practitioners and eye specialists from missing IOFBs. Of note, 1 IOFB was still missed on a CT scan in this cohort and not found until the primary open-globe repair of the corneal-scleral laceration given the IOFB's nonmetallic composition.

In general, the visual outcomes were favorable, with most patients (83%) attaining a VA of 20/30 or better at the final follow-up. These outcomes show better vision in this delayed IOFB cohort than in other cohorts of open-globe injuries with IOFBs; for example, in 1 study the median final VA was 20/60, and in another study 82.8% had a VA of 20/50.^{4,6}

The presenting VA is an established predictor of the final VA in cases of open-globe injuries^{4-6,18}; as such, the generally good visual outcomes in our cohort are consistent with the presenting VAs and previously published data. However, there were serious complications, typically related to longer delays in the diagnosis. Siderosis is 1 of the most serious complications that can occur when an IOFB is missed. In our study, siderosis occurred in 5 patients (28%) at presentation, with a delay in diagnosis ranging

from 9 weeks to as long as 10 years. Although these patients all had excellent central vision, significant retinal toxicity is clearly seen in our illustrative case, with visual field constriction on Goldmann visual field testing (Figure 1) as well as retinal thinning on macular optical coherence tomography (Figure 1). The timeline for the development of siderosis is highly dependent on the composition of the metallic foreign body, its size and shape, and its location in the eye; thus, it is difficult to predict when siderosis might develop in individual cases.²¹

Although IOFBs have been linked to RD, endophthalmitis, and an increased risk for PVR, in particular in the setting of delayed removal,⁶ these did not occur at a high rate in our study. Approximately one quarter of patients had retinal tears on presentation; however, only 1 patient had endophthalmitis and only 1 had an RD. Of the patients with retinal tears at presentation, 3 (75%) had IOFBs embedded in the retina while 1 (25%) had an intralenticular IOFB. The mechanism of retinal tear development when the IOFB is not in the posterior pole may be related to vitreous traction from the impact and the presence of the foreign body, even without it directly entering the posterior segment.

Over the course of the follow-up, only 1 patient developed an RD, 1 developed a giant retinal tear, and none developed endophthalmitis or PVR. This may be because the missed IOFBs tended to be small and perhaps less likely to cause anatomic disruption. It may also be related to the mechanism of the IOFB. For example, a study of delayed IOFB removal resulting from trauma in combat also did not report an increased risk for endophthalmitis, potentially as a result of initial antibiotic treatment or that the explosive mechanism of injury created sterile IOFBs.¹⁶

On the other end of the spectrum, and representing a different type of missed IOFB, is the case of an eye that presented with NLP. The globe was grossly misshapen, and the intraocular contents were disorganized, with uveal prolapse, globe collapse, RD, and hemorrhagic choroidals. In this case, the IOFBs were not clearly identified on the initial B-scan or CT, likely in the setting of the significant trauma burden. The IOFBs were also not identified on primary repair.

Subsequently, 3 weeks later, the patient had PPV and lensectomy, at which time several yellow-brown fibrous foreign bodies were removed. On histopathology, these were found to consist of birefringent foreign material with numerous neutrophils. The combination of gross anatomic disruption and the nonmetallic composition of these foreign bodies likely contributed to the delay in the diagnosis of the IOFBs. This case highlights another important type of clinical scenario in which a high index of suspicion for IOFB should be maintained. Unfortunately, it is not likely that earlier IOFB recognition or removal would have improved this patient's final outcome.

Our study has 2 strengths; that is, it includes cases from different geographic regions (Northeast, Midwest, and Southeast) and cases from several healthcare models (large academic centers, multispecialty group practice, and retina-only referral practice). This study has several limitations, including its retrospective and nonconsecutive nature, which may introduce recall bias. In addition, given that all patients ultimately presented to care with a

vitreoretinal surgeon, there may be other patients with delayed or missed IOFBs who did not present for care with an eye doctor. These patients may have differences in presentation. Thus, this study may be biased more toward delayed IOFBs that caused complications vs those that did not. Last, the denominator for the total number of IOFBs in this timeframe is not known given the multicenter nature of this study.

In summary, this study highlights cases of missed or delayed IOFBs. These patients can present in the emergency setting as well as in an ophthalmology or optometry specialty clinic with favorable vision and self-sealing wounds. Although in general the average outcomes were excellent, there might be vision-threatening sequelae, including siderosis, endophthalmitis, and RD.

Ethical Approval

The study conformed to the tenets of the Declaration of Helsinki and was prospectively approved by the Institutional Review Board, Massachusetts General Brigham (protocol ID #2023P002796).

Statement of Informed Consent

The requirement for informed consent was waived given the retrospective nature of the study.

Declaration of Conflicting Interests

Dr. Patel is a consultant to Alcon, Allergan, Alimera, Apellis, Biogen, DORC, EyePoint, Genentech, RegenxBio, and Regeneron. Dr. Miller is a consultant to Alcon, Allergan, Carl Zeiss, Genentech, Sunovion, and Topcon. Dr. Russell has been a consultant to Carl Zeiss. Dr. Breazzano is a consultant to and speaker for Iveric Bio, unrelated to the present work. Dr. Elliott is a consultant to Alcon, Aldeyra, Apellis, DORC, Genentech, Neurotech, Pykus, and RetMap; has received research grants from Neurotech and Unity Biotechnology; is a DSMB member for Asclepix, Aviceda, Clearside, and EyeBio; and is a stockholder for Aldeyra. None of the other authors declared potential conflicts of interest with respect to the research, authorship, and/or publication of the article.

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References

- Mir TA, Canner JK, Zafar S, Srikumaran D, Friedman DS, Woreta FA. Characteristics of open globe injuries in the United States from 2006 to 2014. *JAMA Ophthalmol.* 2020;138:268-275.
- Patel SN, Langer PD, Zarbin MA, Bhagat N. Diagnostic value of clinical examination and radiographic imaging in identification of intraocular foreign bodies in open globe injury. *Eur J Ophthalmol.* 2012;22:259-268.
- Yiğit O, Yürüktümen A, Arslan S. Foreign body traumas of the eye managed in an emergency department of a single-institution. *Ulus Travma Acil Cerrahi Derg.* 2012;18:75-79.
- Zhang Y, Zhang M, Jiang C, Qiu HY. Intraocular foreign bodies in China: clinical characteristics, prognostic factors, and visual outcomes in 1421 eyes. *Am J Ophthalmol.* 2011;152:66-73.e1.
- Greven CM, Engelbrecht NE, Slusher MM, Nagy SS. Intraocular foreign bodies: management, prognostic factors, and visual outcomes. *Ophthalmology.* 2000;107:608-612.
- Jonas JB, Knorr HLJ, Budde WM. Prognostic factors in ocular injuries caused by intraocular or retrobulbar foreign bodies. *Ophthalmology.* 2000;107:823-828.
- Vingopoulos F, Wang Y, Grob S, et al. Open-globe injury with intraocular foreign body. *J Vitreoretin Dis.* 2020;5:288-294.
- Jaja Z, Laghmari M, Daoudi R. Scleral granuloma revealing intraocular foreign body. *QJM.* 2015;108:251-252.
- Park YM, Jeon H-S, Yu H-S, Lee J-S. A subconjunctival foreign body confused with uveal prolapse. *Indian J Ophthalmol.* 2014;62:730-731.
- Suman S, Kumar A, Rathod HU. Subconjunctival foreign body with suspected scleral penetration. *Trauma Case Rep.* 2022;38:100613.
- He N, Lv Z. A rare asymptomatic metallic intraocular foreign body retained in the anterior chamber for 15 years: a case report. *Medicine.* 2021;100:e26470.
- Archer DB, Davies MS, Kanski JJ. Non-metallic foreign bodies in the anterior chamber. *Br J Ophthalmol.* 1969;53:453-456.
- Dong PN, Duong NTN, Cung LX, et al. Bullous keratopathy secondary to anterior chamber angle foreign body. *Open Access Maced J Med Sci.* 2019;7:4311-4315.
- Mahmoud A, Messaoud R, Abid F, Ksaa I, Bouzayene M, Khairallah M. Anterior segment optical coherence tomography and retained vegetal intraocular foreign body masquerading as chronic anterior uveitis. *J Ophthalmic Inflamm Infect.* 2017;7:13.
- Abounaceur A, Elhaj J, El-Hamraoui K, et al. Cases of orbital cellulitis revealing neglected intraocular foreign bodies. *Ophthalmol Res.* 2023;18(1):38-44.
- Colyer MH, Weber ED, Weichel ED, et al. Delayed intraocular foreign body removal without endophthalmitis during Operations Iraqi Freedom and Enduring Freedom. *Ophthalmology.* 2007;114:1439-1447.
- Loporchio D, Mukkamala L, Gorukanti K, Zarbin M, Langer P, Bhagat N. Intraocular foreign bodies: a review. *Surv Ophthalmol.* 2016;61:582-596.
- Thompson JT, Parver LM, Enger CL, Mieler WF, Liggett PE. Infectious endophthalmitis after penetrating injuries with retained intraocular foreign bodies. National Eye Trauma System. *Ophthalmology.* 1993;100:1468-1474.
- O'Duffy D, Salmon JF. Siderosis bulbi resulting from an intralenticular foreign body. *Am J Ophthalmol.* 1999;127:218-219.
- Wu T-T, Kung Y-H, Sheu S-J, Yang C-A. Lens siderosis resulting from a tiny missed intralenticular foreign body. *J Chin Med Assoc.* 2009;72:42-44.

21. Casini G, Sartini F, Lojudice P, Benini G, Menchini M. Ocular siderosis: a misdiagnosed cause of visual loss due to ferrous intraocular foreign bodies—epidemiology, pathogenesis, clinical signs, imaging and available treatment options. *Doc Ophthalmol*. 2021;142:133-152.
22. Costa VP, Smith M, Spaeth GL, Gandham S, Markovitz B. Loss of visual acuity after trabeculectomy. *Ophthalmology*. 1993;100:599-612.
23. Bowe T, Serina A, Armstrong M, et al. Timing of ocular hypertension after pediatric closed-globe traumatic hyphema: implications for surveillance. *Am J Ophthalmol*. 2022;233:135-143.
24. Pieramici DJ, Sternberg P, Aaberg TM, et al. A system for classifying mechanical injuries of the eye (globe). *Am J Ophthalmol*. 1997;123:820-831.
25. Chacko JG, Figueroa RE, Johnson MH, Marcus DM, Brooks SE. Detection and localization of steel intraocular foreign bodies using computed tomography: a comparison of helical and conventional axial scanning. *Ophthalmology*. 1997;104:319-323.
26. Dass AB, Ferrone PJ, Chu YR, Esposito M, Gray L. Sensitivity of spiral computed tomography scanning for detecting intraocular foreign bodies. *Ophthalmology*. 2001;108:2326-2328.