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Visual and Anatomic Outcomes in Perforating Ocular Injuries

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Abstract

Purpose: This article reports the presentation, management, and outcomes in patients suffering perforating ocular injuries.

Methods: A retrospective review was conducted at a single ophthalmology Level 1 trauma center. Patients with evidence of traumatic ocular perforation, with surgical intervention attended by a single vitreoretinal surgeon (W.F.M.), were reviewed between 2009 and 2017.

Results: Six eyes from 6 patients with perforating ocular injuries were studied. All patients were male, between ages 11 and 56 years. Perforation was the result of gunshots (3), other accidental injury (2), or surgical complication (1). Varying degrees of retinal detachments were seen in all 6 patients. Pars plana vitrectomy, with endolaser around posterior entry or exit wounds, was performed on average 21.7 ± 8.9 days from the time of injury (range, 0-58 days). In all cases with intraorbital foreign bodies, the foreign bodies were left in place. The most recent postoperative visual acuity ranged from 20/25 to counting fingers. Missile injuries tended to have poorer vision. All cases achieved full anatomic attachment at most recent follow-up. There have been no orbital complications related to retained intraorbital foreign bodies, including endophthalmitis, orbital infections, or mechanical strabismus.

Conclusion: This study demonstrates successful anatomic outcomes of 6 cases of perforating ocular injuries. Visual outcomes were variable, though missile injuries demonstrated worse prognosis, whereas several nonmissile macula-involving cases achieved quite favorable results. Although traumatic perforating injuries generally have guarded visual prognoses, favorable results may be achieved in select scenarios.

Keywords

double-penetrating; double-perforating; foreign bodies; foreign body; open-globe injury; perforating; through and through

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Ethical Approval

This case series was conducted in accordance with the Declaration of Helsinki. The collection and evaluation of all protected patient health information was performed in a HIPAA (Health Insurance Portability and Accountability Act)-compliant manner.

Statement of Informed Consent

This study received institutional review board approval. A waiver of informed consent was obtained for the research and publication of this article.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Introduction

Perforating ocular injuries are characterized by an object entering through one part of the eye and exiting through another,¹ generally suggesting particularly high-energy insults, which are often left with intraorbital foreign bodies (IOrbFBs). In such cases, primary closure of accessible ocular wounds is typically performed, but the optimal management of poorly accessible or nonaccessible wounds and a retained IOrbFB is not well established.

Other case reports and series have demonstrated variable but overall limited visual and anatomic outcomes.²⁻¹⁰ The diversity in presentations, coupled with the urgency of required intervention in open-globe injuries (OGIs), makes rigorous interventional studies difficult to perform. In this series, we discuss 6 consecutive cases of perforating eye injuries, including presentation, imaging, and management, to provide further insight into this challenging ophthalmic scenario.

Methods

A noncomparative retrospective case series was performed to review perforating injuries undergoing globe closure and pars plana vitrectomy (PPV) surgery by a single surgeon (W.F.M.) from January 1, 2009 to December 31, 2017. The study was approved by the institutional review board of the University of Illinois at Chicago. Patients were identified by International Classification of Diseases, ninth revision/10th revision, Current Procedural Terminology codes, or surgical log diagnosis.

Patients who were identified initially presented to our institution through the emergency department (ED), either primarily or as transfers from outside EDs. The ophthalmology service was consulted for OGI or suspected intraocular foreign bodies (IOFBs) or IOrbFBs after evaluation by an emergency medicine physician to ensure there were no life-threatening complications of the injury. Initial ophthalmology evaluation included visual acuity (VA), pupillary assessment, and intraocular pressure (IOP) if appropriate. Careful external and anterior segment examinations were performed to determine areas of laceration/penetration or uveal prolapse. Additionally, an assessment of globe stability, anterior chamber formation, hyphema, hypopyon, lens violation, and iris abnormalities was performed. The patients were then dilated and funduscopy examination was performed, taking care not to manipulate the globe extensively if there was a risk of worsening the injury. Patients underwent thin-cut computed tomography (CT)-scan imaging to evaluate for IOFBs and IOrbFBs and to rule out other central nervous system abnormalities.

The patients were checked for tetanus status and updated as needed, and basic labs were checked including complete blood count, comprehensive metabolic panel, coagulation panel, and toxicology studies, if applicable. The patients were started on oral or intravenous (IV) antibiotics with or without topical antibiotics. The standard systemic antibiotic regimen for a patient without allergy was cefazolin 1 g IV every 8 hours and moxifloxacin 400 mg IV every 12 hours while inpatient. The eye was shielded and the patient was brought to the operating room (OR) for urgent repair within 24 hours of presentation.

With regard to surgical repair, the specific cases will be discussed in greater detail in the case presentations. In general, large open wounds were approximated first with 8-0, 9-0, or 10-0 nylon sutures to repair the sclera, limbus, and cornea, respectively. Then, either concurrently or sequentially, 3-port 20-, 23-, or 25-gauge (G) PPV was performed to repair any posterior segment pathology.

Patients were seen in the retina clinic for follow-up, where a full ophthalmologic assessment was performed in addition to B-scan ultrasonography, if there was no view to the posterior pole. All clinical data including VA, IOP, pupillary examination, anterior segment examination, description of perforating sites, posterior segment status, and imaging were recorded. Follow-up complications such as retinal detachment (RD), cataract, hypotony, and vitreous hemorrhage (VH) were noted, as well as any further interventions. Patients suffering ocular trauma with evidence of foreign-body penetration through 2 distinct parts of the eye were included in this review. Evidence of perforation was largely confirmed by radiologic imaging.

Results

A summary of pertinent data from the 6 cases is presented in Table 1.

Case 1.

An otherwise healthy 11-year-old boy was transferred to the ED hours after being shot in the left eye at close range by a BB gun. VA in the affected eye was no light perception (NLP). There was an afferent pupillary defect (APD) and IOP was soft to gentle palpation. Anterior examination was notable for subconjunctival hemorrhage (SCH) and a 5-7 mm scleral wound at 2 o'clock, 1-2 mm posterior to limbus, with uveal tissue exposed at the site of the wound. There was an 80% to 90% hyphema obstructing view of the fundus.

A B-scan ultrasound was deferred in the setting of globe instability. A CT scan of the orbits demonstrated a radiodense foreign body at the apex of the left orbit, adjacent to the optic nerve, with some concern for optic nerve damage. The patient was taken to the OR for open-globe repair the same day. During surgery, prolapsed uveal tissue was removed and the anterior scleral laceration was closed, allowing for globe formation and maintenance of IOP. Attempts to locate the posterior exit wound were unrevealing at the time of primary closure. The IOrbFB was left in place.

Two weeks postoperatively, his VA was light perception (LP) and there was persistent VH and a tractional RD. Therefore, the patient underwent 20-G PPV. A posterior exit wound was found intraoperatively, as well as a large amount of scar tissue over the macula and optic nerve regions (Figure 1); therefore, a careful membrane dissection was performed. Endolaser was applied surrounding the exit wound and areas of scar tissue. At most recent follow-up, 2 years after initial injury, the retina was fully attached, and the patient's VA was counting fingers (CF) at 1 ft (30 cm).

Case 2.

An otherwise healthy 36-year-old man was transferred to our ED after sustaining projectile injury during mechanical work on his car. His VA was hand motion (HM). IOP testing was deferred. The right pupil was traumatic and nonreactive but there was no reverse APD. Right-eye motility was restricted both on abduction and adduction. Slit-lamp examination revealed a 3 mm full-thickness horizontal laceration extending from the center of the cornea temporally to the limbus, with iris prolapse and lens violation. There was no view to the fundus through cataract, and B-scan ultrasonography was deferred in the setting of open globe. CT of the orbits demonstrated a radiodense foreign body in the posterior aspect of the right lateral rectus, outside the globe (Figure 2). The patient underwent primary corneal laceration repair, pars plana lensectomy, and anterior vitrectomy. Intraoperative fundus examination after lensectomy was significant for VH but did not reveal any RD. Ten days following repair of the OGI, the patient had CF VA with an IOP of 21 mmHg. Fundus examination revealed a posterior exit wound in the temporal macula, as well as dehemoglobinized VH tracking toward and partially obstructing the suspected exit wound, but no RD. To better visualize the exit site and clear the VH, 25-G PPV was performed, with endolaser surrounding the exit wound (Figure 3A), followed by 20% sulfurhexafluoride (SF₆) gas tamponade. At most recent follow-up 2 years postrepair, despite some macular folds (Figure 3, A and B), his VA was 20/40, the retina was fully attached, and there were no further surgical interventions.

Case 3.

An otherwise healthy 31-year-old man presented to the ED with loss of vision in his right eye after sustaining a shotgun blast to his face. He also had several other bullet injury sites, including the chest, face, and left orbit, without left-globe compromise. Presenting VA in the right eye was HM, and IOP testing was deferred. The pupil was distorted and the iris had a 3 mm round defect adjacent to the scleral wound, but was reactive without APD. A 5 mm scleral laceration was found at the limbus at 3 o'clock with vitreous plugging, but not extending into the cornea. A small hyphema was noted in the anterior chamber along with a traumatic cataract with lens violation. There was no view to the fundus. CT of the orbits was notable for a radiodense foreign body in the right orbit at the insertion of the lateral rectus and associated emphysema and distortion of the globe (Figure 4A). There were multiple radiodense foreign bodies in the lateral aspect of the left orbit as well, but the globe appeared intact. The patient was taken to the OR for primary globe repair, during which the prolapsed uvea was replaced and the anterior scleral laceration was repaired. No posterior laceration was found at the time.

Despite poor initial follow-up, the patient returned to the clinic 1 month postoperatively, with HM VA and dense VH, but a grossly attached retina. B-scan ultrasound demonstrated a persistent foreign body within the lateral rectus muscle (Figure 4B). He underwent 25-G PPV, during which a suspected exit wound was discovered temporal to the macula. Lensectomy was performed, and chorioretinal scarring was seen in the temporal macula, suspected to be the exit point. Endolaser was performed around the suspected exit wound (Figure 4C), and 20% SF₆ gas tamponade was used. At most recent follow-up 6 months

postoperatively, the patient had a VA of 20/100 and anatomic attachment. No further surgical interventions were required.

Case 4.

An otherwise healthy 53-year-old man was referred to our clinic for evaluation of decreased vision and hypotony after complicated cataract surgery of his left eye, performed at an outside facility. There was reported to be a loss of red reflex during retrobulbar nerve blockade. There was postoperative hypotony, wound leak, and VH per the referring physician. At presentation, VA was CF at 6 ft (2 m). Pupils were reactive without APD. The superior extracapsular corneal wound was Seidel positive. There was no view to the fundus but B-scan ultrasonography demonstrated VH without RD.

He underwent combined corneal wound revision and 25-G PPV the day after presentation. Intraoperatively, 2 discrete retinal perforation sites were noted with mild surrounding sub-retinal hemorrhage and localized RD (Figure 5). It was suspected that these sites represented entry and exit wounds from the retrobulbar needle. Endolaser was applied around the perforating sites. At latest follow-up, 1 year postsurgery, the patient's VA was 20/30 and he has not required further surgical intervention.

Case 5.

An otherwise healthy 24-year-old man presented to the ED for loss of vision after feeling a projectile hit his right eye while sawing wood at work. The patient was seen at an outside ED, diagnosed with a corneal abrasion, and discharged. His vision continued to worsen and he presented to our facility the following day. His VA was LP in the right eye and his IOP was 13 mmHg. The anterior segment was notable for corneal edema, multifocal perilimbal bullous SCH, and a 5 mm self-sealed, superotemporal, full-thickness corneal laceration, with formed anterior chamber.

The fundus was not visualized but CT of the orbits revealed a metallic foreign body posterior to the globe (Figure 6A). The foreign body was also visible on B-scan ultrasonography (Figure 6B), which also demonstrated vitreous hemorrhage and a small area of localized RD. CT of the orbits supported these findings of a metallic foreign body posterior to the globe (Figure 6A). He was treated with IV cefazolin and levofloxacin and underwent PPV within 3 days of presentation to our facility. During vitrectomy, an exit wound was noted just temporal to the fovea with overlying VH and tractional vitreous attachments. There was also a large retinal dialysis found spanning 6 o'clock to 12 o'clock. The hemorrhage and hyaloid traction were removed and laser retinopexy was performed around the penetration site, with attention to avoid the fovea (Figure 7, A and B) and surrounding the dialysis. There was no IOFB noted. Fifteen percent perfluoropropane (C₃F₈) tamponade was used. At the patient's most recent follow-up, 5 months postoperatively, his best-corrected VA is 20/40. His retina demonstrates macular folds (Figure 7, C and D) but is fully attached with no subretinal fluid or proliferative vitreoretinopathy (PVR) surrounding the posterior exit wound.

Case 6.

A 48-year-old man with history of alcoholism presented to the ED after being accidentally shot in the left eye with a BB gun earlier that day. On examination, VA was HM and IOP measurement was deferred. Anterior examination was notable for 360° bullous SCH and hyphema, which prevented a view of the pupil, lens, and fundus. A CT of the orbits demonstrated a metallic foreign body medial to the left globe (Figure 8). He received IV cefazolin and levofloxacin. The patient underwent open-globe repair the following day, during which a 7 mm laceration underlying the lateral rectus muscle (likely entry wound) and a 5 mm laceration inferior to the medial rectus muscle (likely exit wound) were found and repaired. On follow-up he was found to have a dense cataract as well as VH and RD on B-scan ultrasound, and underwent 25-G PPV within several weeks of presentation as the patient had poor follow-up.

After lensectomy, the posterior pole was visualized and demonstrated retinal tears along the aforementioned entry and exit wounds, as well as associated RD. Following core vitrectomy removing traction from areas of detachment, air/fluid exchange was performed along with endolaser around the retinal tears and in a diffuse scatter pattern. Silicone oil was used for tamponade. At the latest follow-up 2 months postoperatively, his VA was 20/100 and his retina was fully attached under silicone tamponade, but the patient has been lost to follow-up, still with silicone in place.

Conclusions

Six cases of perforating ocular injuries sustained via various mechanisms (gunshots, metallic projectiles, and a needle perforation) are presented. Similar to the demographics of numerous previous published studies, all patients in our series were male and relatively young.^{5,10-12} The presenting VAs were limited, ranging from CF to NLP, though at final follow-up, with a minimum of 1 month (mean, 14 months), VA ranged from 20/25 to CF. The gunshot injuries tended to have poorer visual outcomes compared with the other mechanisms of injury. All cases demonstrated full anatomic attachment at the time of latest follow-up, but some have been lost to follow-up.

Although the visual and anatomic outcomes in our cases are generally quite favorable, the surgical approaches varied widely. Several key decisions were made at various points in the management of each case (eg, timing of initial surgical intervention, timing and extent of PPV, choice of intraoperative tamponade agent, management of posterior exit wound or wounds, and management of IOFBs), and there is not a consensus regarding the optimal choice for some of these decisions.

The timing of initial surgical repair in our cases followed general trends in open-globe repair. Initial OGI repair, involving closure of anterior segment–penetrating wounds, occurred within 24 hours of presentation in 5 of our cases, and was postponed to 3 days in 1 case in the setting of a self-sealed entry wound with a well-formed globe and no apparent uveal incarceration. In general, early primary repair (within 24 hours) is recommended for OGIs as this has been associated with reduced incidence of endophthalmitis and overall better visual outcomes.¹³⁻¹⁵ The finding of self-sealed wounds is an independent protective

factor in terms of endophthalmitis,¹³ and in our one case with a self-sealed entry wound, a delay in primary repair did not lead to endophthalmitis or any other major complication.

Following primary repair of an open globe, the decision to utilize PPV has many indications, including but not limited to RD, nonclearing VH, and PVR. PPV is generally indicated in the setting of posterior globe perforation; however, there is some suggestion based on case reports that perforations specifically caused by sharp objects may be managed conservatively, with laser retinopexy but without vitrectomy, and still achieve good results.²

Injuries from sharp objects less often cause extensive RD and are thought to result in more-ordered wound healing and suffer less from PVR, as compared with missile injuries. In contrast, high-energy projectiles, such as bullets, are likely to cause disruptive changes that may lead to complications such as incomplete wound healing, nonclearing VH, PVR, and tractional RDs. Missile injuries generally achieved worse visual outcomes in our series of patients, similar to results reported in other series.^{8,9,12,16}

Indeed, whereas location of the perforating sites may be a significant prognostic indicator,¹⁵ our case series demonstrates the overwhelming importance of injury type on visual outcome, as a patient with an anterior gunshot wound (zone 3, anterior to equator) had significantly worse outcomes than a needle injury that entered the macula. Regardless of injury type, however, PPV continues to be generally indicated in the case of ocular perforation, even if only for improved visualization.

The timing and surgical approach for PPV is a controversial topic without general consensus. There have been evidence-based recommendations for anywhere from less than 3 days to more than 2 weeks but less than 1 month from the time of injury.^{9,17,18} Benefits of early vitrectomy may include earlier visual recovery, reduced complications such as PVR, and reduced total number of surgeries. Conversely, early PPV may pose a higher risk of intraoperative hemorrhage, may be more technically challenging in the setting of a structurally compromised globe, and may be logistically more difficult to arrange because of specific hospital settings and possible social factors (eg, alcohol intoxication). Additionally, delaying PPV may allow for an easier surgery by allowing the corneal or scleral wounds to heal, and allowing the hemorrhage to settle for more definitive preoperative assessment. In our cases, PPV was performed concurrently with the OGI repair in 2 cases, but ranged up to almost 2 months postinitial repair of the globe. Delay in PPV in our cases was not intentional but rather because the patient was lost to follow-up. Regardless of PPV timing, anatomic stability was achieved in all cases.

The intraoperative management of the posterior exit wounds represents another controversial management consideration. In our cases, all posterior exit wounds were identified and barricaded with endolaser at the time of vitrectomy. Although localized proliferation around the posterior wounds was dissected, there was no attempt to externally suture the wounds, and IOrbFBs were left in place.

Endolaser retinopexy around a posterior exit wound is commonly practiced to prevent secondary RD,^{3,6,19} though it may present a challenge in cases with macular exit wounds. In such cases, some may recommend conservative management without endolaser, with the

thought that inflammation and scarring of the wound may be enough to prevent RD.² In our cases, macular wounds without direct foveal involvement may still achieve good visual outcome with laser photocoagulation. In addition to RD, the posterior wound may potentially involve retinal incarceration and eventually result in macular folds, compromising vision.

Some authors have proposed prophylactic chorioretinectomy and drainage of any subretinal blood, in addition to laser retinopexy around the posterior wound, to prevent this complication.²⁰ Theoretically, this would allow for removal of inflammatory material, prevent retinal folds, and remove a nidus of PVR development. Several studies have demonstrated some benefit from this procedure,^{6,16,21} and late chorioretinectomy, even months after the trauma, may also be beneficial.²² Several of our cases developing retinal folds had macular wounds, making chorioretinectomy a somewhat riskier intervention. Nonetheless, prophylactic chorioretinectomy may have been considered, and secondary intervention may still prove useful.

Finally, regarding the posterior scleral exit wounds, though they were not surgically closed, self wound closure was noted in all cases without acute or long-term hypotony. Animal studies as well as histopathological human studies have suggested that scleral wounds from perforating injuries may be expected to close spontaneously within 1 week,^{23,24} and this spontaneous closure has been observed clinically in most cases.^{3,5,16}

The choice of tamponade agent (eg, silicone oil or gas, and C₃F₈ vs SF₆) also lacks consensus. Silicone oil may be of theoretical benefit in that it has antimicrobial properties²⁵ and provides a potential physical barrier to the development of PVR extending into the vitreous cavity.²⁶ Its high specific gravity provides structural support and, while in place, may limit retinal collapse from PVR. However, gas, particularly C₃F₈, has been shown to achieve similar anatomic reattachment rates in various clinical settings while also having the significant benefit of not requiring further surgery for removal.²⁷ This benefit is particularly important in younger patients, who may still develop PVR behind silicone oil and are more likely to suffer RD on silicone removal.²⁸ In our cases, C₃F₈, SF₆, silicone oil, and air were all employed as tamponade agents, and the decision was made on a case-by-case basis. No apparent differences were noted between the specific agents in terms of visual or anatomic outcomes, although the study is not designed to test for these differences.

All but one of our cases (the needle injury) involved an injury resulting in IOrbFB. Each IOrbFB was metallic and was readily located and measured with a CT scan, the radiologic modality of choice in the case of IOrbFB.²⁹ In each of these cases, IOrbFBs were left without foreign-body extraction. Whereas in general posterior IOFBs are removed if possible at initial PPV, removal of an IOrbFB presents more of a challenge.

Primary removal of an IOrbFB may confer more risk than benefit given the amount of traction and external pressure that would need to be placed on a structurally compromised eye. The overall consensus is for conservative management without removal of a metallic IOrbFB unless complications arise—such as strabismus, infection, or fistula formation—or

unless a notable metal such as iron or copper is suspected, which can result in toxicity and increased inflammatory response.^{5,29-31}

In the case of organic IOrbFBs, most would recommend removal if at all possible.²⁹ Inorganic foreign bodies are thought to pose less of an infectious or inflammatory risk for the patient.⁵ Our cases of IOrbFBs all involved metallic foreign bodies, and there were no instances of endophthalmitis or significant orbital complications related to the retained IOrbFBs. However, close follow-up is needed for all cases of retained IOrbFBs, as inorganic IOrbFBs may still carry infectious organisms with them and result in serious infectious complications.³²⁻³⁵

Given the diversity of presentations with OGIs, and perforating injuries in particular, it is unlikely that a single treatment approach would prove ideal for all patients; rather, treatment will need to be tailored on an individual basis. An overall set of management principles to consider has been presented that may enable optimal outcomes. Though visual outcomes are highly dependent on the location of injury and development of PVR, anatomic stability may be achieved in the vast majority of perforating OGIs.

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Figure 1. Patient 1, postoperative fundus photographs of the left eye, seen with (A) more nasal and (B) more temporal views. Subretinal fibrosis and epiretinal proliferative vitreoretinopathy are seen overlying the macula, with dragging and elevation of the vascular arcades.

Figure 2. Patient 2, computed tomography scan of the head and orbits on presentation. (A and B) Axial, (C) coronal, and (D) sagittal slices. Demonstrated is a radiodense object lodged in the right lateral rectus with emphysematous changes along the likely projectile path through the globe.

Figure 3.

Patient 2, (A) fundus photo of the right eye, 2 weeks postoperatively. Posterior exit wound seen in temporal macula with surrounding laser retinopexy. Laser was applied more extensively temporally than nasally. (B) Spectral-domain optical coherence tomography en face and (C) B-scan photographs demonstrating macular folds emanating from the posterior exit wound.

Figure 4.

Patient 3, (A) computed tomography of the orbits on presentation, demonstrating radiodense objects in the medial left orbit adjacent to the globe, and lateral right globe with corresponding emphysematous changes in the adjacent globe. (B) B-scan ultrasonograph of the right eye, L9 view, demonstrating foreign body posterior to the globe, embedded within the right lateral rectus muscle. A postoperative B-scan ultrasonograph is depicted for image clarity. (C) Postoperative fundus photograph of the right eye demonstrating a large exit wound in the temporal macula with surrounding laser scars.

Figure 5. Patient 4, postoperative fundus photograph of the left eye. (A) Superior exit wound depicted with laser barricade surrounding. (B) Inferotemporal entry wound depicted with laser barricade.

Figure 6. Patient 5, (A) computed tomography of the orbits. A radiodense foreign body is seen posterior to the right globe. High-density material within the posterior vitreous suggestive of hemorrhage is present in addition to air anteriorly. (B) B-scan ultrasound image demonstrating foreign body posterior to the globe.

Figure 7. Patient 5, fundus photography of the right eye demonstrating (A) temporal macular scar with laser barricade most prominently temporal to the lesion and (B) macular folds emanating from the macular scar. Spectral domain-optical coherence tomography (C) en face and (D) B-scan postoperative photographs of the right eye depicting a temporal macular scar with subretinal fibrosis and surrounding macular folds.

Figure 8. Patient 6, computed tomography of the orbits, demonstrating a 0.6 mm spherical radiodense foreign body within the medial orbit adjacent to the globe. Emphysematous changes within the globe and lateral to the left globe are seen, as are multiple irregular areas of high density within the left globe.

Table 1.

Perforating Injuries: Cases and Outcomes Summary.

Patient	Object	Time to OGR, h	Time to PPV, d	Tamponade Agent	VA Initial	VA Most Recent, m	Retina Reattached	Exit Wound Location
1	BB	<24	30	C ₃ F ₈	NLP	CF (34)	+	Sup. macula
2	Chisel	<24	16	SF ₆	HM	20/40 (28)	+	Temp. macula
3	Shotgun	<24	58	SF ₆	HM	CF (5)	+	Temp. macula
4	Needle	<24	0	Air	CF	20/30 (12)	+	Inf. midperiph.
5	Sawing metal	<72	0	C ₃ F ₈	LP	20/40 (6)	+	Temp. macula
6	BB	<24	22	Oil	HM	HM (2)	+	Ant. to equator

Abbreviations: Ant., anterior; C₃F₈, perfluoropropane; CF, counting fingers; HM, hand motion; Inf., inferior; LP, light perception; midperiph, midperipheral; NLP, no light perception; OGR, open-globe repair; PPV, pars plana vitrectomy; SF₆, sulfurhexafluoride; Sup., superior; Temp., temporal; VA, visual acuity.